AN INVESTIGATION OF FRUIT FLIES *(Trypetidae: Diptera)* IN QUEENSLAND

1. INTRODUCTION, SPECIES, PEST STATUS AND DISTRIBUTION

By A. W. S. MAY, M.Agr.Sc., Ph.D.*

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*Assistant to Director, Division of Plant Industry, Queensland Department of Agriculture and Stock. (Formerly Senior Entomologist)

SUMMARY

The early history of fruit flies in eastern Australia, their identification, pest status and distribution, are reviewed. Evidence is presented that the Queensland fruit fly (*Strumeta tryoni* (Froggatt)), the most important Dacinae in Australia, was a pest of commercial fruit at least as early as 1853, and prior to 1900 was indigenous to an area in eastern Australia not greatly different from that recorded today.

Fifty-four species of Dacinae are recorded from Queensland. To facilitate the identification of these, studies of diagnostic characters were undertaken. These involved a general appraisal of characters and variations for all species.

The significance of colour variation associated with age of specimen when captured, and host, was investigated for *S. tryoni* and recorded for other species. Differences in the development of melanin in cutaneous layers were associated with nutrition during larval development, while alterations in subcutaneous markings were a function of age.

A limited statistical study of wing and ovipositor measurements of *S. tryoni* revealed the limitations of these characters for diagnostic purposes.

A revised generic classification of the Dacinae primarily based on fusion or non-fusion of abdominal tergites is presented. This and other new concepts of generic classification have introduced synonymy. A new arrangement of genera is presented.

Descriptions of several Queensland Dacinae have been revised. These reveal, more clearly, differences among closely allied species and recognize aberrant and colour forms within species.

A list of species of Dacinae occurring in Queensland is given together with new or recent synonymy. A key to these species is presented which permits species determination without recourse to generic classification and overcomes complete reliance on chaetotaxic and secondary sexual characters. Identification is possible also should either sex be considered.

Pest status determined from records of damage to commercial fruit, host studies, field observations and marketing reports has enabled the grouping of species as major or minor pests or those of no commercial importance. Eleven Queensland Dacinae have been bred from commercial hosts; five of these are considered of major importance.

Locality records are presented for all Queensland species. Records for the better known are presented on maps; those for *S. tryoni* are given for eastern Australia, the remainder for Queensland only. The evidence demonstrates that *S. tryoni* is endemic to an area of eastern Australia from East Gippsland (Victoria) in the south to Cape York Peninsula (Queensland) in the north and extending inland to at least the western slopes of the Great Dividing Range. Other authentic records were obtained for isolated centres in western New South Wales and Queensland and the Northern Territory.

I. INTRODUCTION

The first comprehensive record of fruit fly damage to commercial fruits in Australia was by Tryon (1889)* in a report on an "Inquiry into Diseases affecting the Fruit-trees and other Economic Plants in the Toowoomba District". Although

* Tryon (1889) stated (p. 3) that: "With the exception of enquiries conducted by private individuals, efforts to investigate the diseases of plants cultivated in the colony seem to have been limited to what has been accomplished by the Board appointed in February, 1875, to "Inquire into the Causes of Diseases affecting Live Stock and Plants" . . . It reported the mere existence of the "grub", in some cases, in the peaches of East and West Moreton and the Darling Downs, and of "disease" in those of Rockhampton."

adequately described, the species concerned was referred to merely as "The Fruit Maggot, Fruit Fly" (Fam. *Diptera,* Gen. *Tephritis*). According to that author (1889), cultivated fruit in this area of Queensland had been damaged by fruit fly as early as 1853; and he concluded that "the Tephritis has been known as a pest on the Darling Downs ever since fruit has been grown there; but that . . . it has only been within the last few years that this pest has been so generally prevalent . . .". Other locality records included Goondiwindi (1869), Roma and Surat (1886) and Ingham (1889). Jarvis (1925*a*) quoted a report of fruit fly damage to deciduous fruit grown in the Brisbane district as early as 1864. In 1892 Tryon stated that "at present it [fruit fly] is responsible for the destruction of considerably more than half of the fruit grown in the southern part of the colony".

Additional records of fruit fly damage were compiled by Tryon (1894–1906) in his reports as Entomologist in the Queensland Department of Agriculture and Stock. These were grouped prior to 1897 under *Tephritis* sp. but subsequently under *Dacus tryoni* and *Chaetodacus tryoni.* A wide host range was reported; it included apple, banana, grape, guava, loquat, orange, mango, passion-fruit, peach, pear, persimmon, plum, pomegranate and quince. These host records were of a general nature and embraced coastal areas as far north as Mackay as well as districts in the Dawson Valley, Darling Downs and on the south-western highlands. Gaps in our knowledge of distribution at this time reflect the lack of authentic records rather than the distribution pattern for the species.

Tryon (1906) remarked that during the 20 years since he had studied the insect ("*Tephritis tryoni* Froggatt") he had never found that it had extended its range of permanent occurrence. He distinguished, however, between districts in which it was permanently endemic and "others to which from time to time it got transported by wind or human agency, but in which it did not permanently subsist". From all evidence available, including unpublished Departmental records, Tryon (1927) concluded that "In Queensland it [*Chaetodacus tryoni* Froggatt] not only occurs throughout the coastal district, but passes far beyond the Dividing Range, even so in the North".

W. W. Froggatt (1899) had written—"It is generally stated among the old time orchardists that fruit fly maggots were known about Sydney in the early days of fruit growing, and that some twelve years ago they were very destructive"; and that fruit grown in and around Sydney and Parramatta prior to 1887 was damaged by fruit fly in wet periods. Tryon (1889) considered that larvae similar to those found in Queensland-grown fruit were common in peaches as far south as Kiama, N.S.W., as early as 1853; and damaged fruit at Port Macquarie in 1865 (Tryon 1927). W. W. Froggatt (1909) reported that fruit fly was a pest to fruit-growers in New South Wales as early as 1852; and that Gosford, 50 miles north of Sydney, was the natural or permanent southern limit of *S. tryoni* in New South Wales—a conclusion in conflict with his earlier report (W. W. Froggatt 1899).

Benson (1895) noted that fruit fly was very prevalent and troublesome in the Cumberland and Northumberland districts of New South Wales during the summer of 1895, and was becoming increasingly more important each year as a pest of late-season fruits in the north-western districts of that State; he also cited the increasing incidence of *S. tryoni* in late-season fruit during a visit in 1894 to the Inverell, Gunnedah, Narrabri, Moree and Warialda districts of the State.

The incidence of fruit fly species in and around Sydney, N.S.W., subsequent to 1898 is confused following the introduction of the Mediterranean fruit fly, *Ceratitis capitata* Wiedemann. This species was bred by French from peaches imported to Victoria from Sydney (W. W. Froggatt 1899). The introduction of this species to the Sydney area was fixed by W. W. Froggatt (1899) as 1898, two years after it was first recorded at Guildford, near Perth, in Western Australia (Fuller 1897). Both introductions followed the large-scale importation of citrus fruit to Australia through Perth and Sydney from Africa by way of Italy. From the Sydney area, *C. capitata* quickly spread through the citrus orchards of New South Wales, where it caused appreciable damage to fruit during the 1898-99 fruit season at most centres south of Newcastle (Tryon 1927). It was found soon afterwards at Albury and in many districts of Victoria (W. W. Froggatt 1909). Records of its presence in orchards near Launceston, Tas., were confirmed (Lea 1899). The species was identified also from Mildura, Vic., in 1906 (Quinn 1907) and by 1907 had become established in the Napier area in New Zealand (W. W. Froggatt 1909).

The large quantities of fruit, chiefly bananas and citrus, exported from Queensland and New South Wales to southern parts of Australia prior to 1900 usually were infested with fruit fly (Quinn 1907). This trade continued for many years before any quarantine inspections were made (Tryon 1906).

French (1909) stated that *C. capitata* had been bred from bananas and oranges imported from Queensland during 1906. There may have been confusion with the somewhat similarly marked trypetid, *Rioxa pornia* (Walker), which is not an uncommon secondary insect in these fruit. A more probable explanation, however, is that French's records were due to the practice of re-exporting Queensland citrus from Sydney to southern States, and the inclusion of locally grown fruit in these consignments (Tryon 1906). Tryon (1927), commenting on these and other reports (W. W. Froggatt 1909) of the breeding of *C. capitata* from Queensland-grown fruits, stated that this species was never endemic in Queensland, although it was bred repeatedly in Brisbane from fruit received from New South Wales; this is confirmed by a study of Tryon's Queensland host-fruit fly records and specimens in the collection of the Queensland Department of Agriculture and Stock.

A general lack of published information masks the picture of distribution and importance of *C. capitata* in eastern Australia subsequent to 1909. Despite an abundance of hosts, this species disappeared and the last record from New South Wales was in 1941 (Allman and Friend 1948).

All fruit flies damaging cultivated fruit in New South Wales and Queensland up to 1878 were referred to merely as the Queensland fruit fly (W. W. Froggatt 1897). Froggatt had used this name in his earliest publication because of the economic importance of the species in the latter State. He gave the name Mediterranean fruit fly to *C. capitata* to distinguish it from the indigenous species (W. W. Froggatt 1899).

The first recorded attempt to identify the indigenous species was made in 1878, when specimens bred from infested oranges collected at Maryborough, Qld., were sent to Kew, England*. Apart from considering these distinct from the genus *Ceratitis,* no systematic position was given. Tryon (1889), though not giving it specific rank, considered it a species of *Tephritis,* and described the larva, pupa and adult. Subsequently, all trypetids bred from a wide range of cultivated fruit collected from centres along the Queensland coastal belt were grouped under *Tephritis* sp. by Tryon (1894 *et seq.*). The Queensland fruit fly was eventually described by W. W. Froggatt (1897) from specimens bred from apples received in Sydney from Tenterfield, N.S.W., and subsequent records were grouped under *Tephritis tryoni* Froggatt.

The true significance of specimens differing from the common species was not recognized for many years, although variants from the common form were noted by W. W. Froggatt (1899, 1909), French (1907, 1910) and Tryon (1912).

French (1907, 1910) recognized that the species commonly bred from cucumbers received in Melbourne from North Queensland was different from Froggatt's *tryoni,* and named it *Dacus tryoni* var. *cucumis* but gave it also the name Queensland fruit fly. Prior to this date, host records for this species, including one from tomatoes at Bowen (Queensland Department of Agriculture and Stock collection), were grouped with records for *tryoni.* One host record for this species in 1910 was listed under *Dacus cucurbitae* Coquillet (records of Queensland Department of Agriculture and Stock).

W. W. Froggatt (1909) pointed out specific differences between French's *cucumis* and *tryoni* and at the same time drew attention to the increasing importance of fruit fly since banana-growing had extended to North Queensland. Quinn (1907) also referred to the high incidence of fruit fly in bananas received at Sydney and Melbourne from Queensland. Some of these records, no doubt, concerned *tryoni* but Tryon (1912) recognized differences between the species attacking bananas grown north of Townsville and the species causing damage to this fruit in southern Queensland. Colour differences on the thorax and

* Tryon (1889, footnote p. 71) stated: "Examples of the Queensland Fruit Fly, found attacking oranges, were sent, in 1878, to the Colonial Office, and on 21st November, 1878, the Secretary of State forwarded a despatch to the Governor, covering a letter from W. T. Thistleton Dyer, Assistant Director of the Royal Gardens, Kew, communicating the substance of a report by Mr. R. McLachlan, F.R.S. In the latter, Mr. McLachlan states that 'the fly that attacks oranges is allied to, but probably distinct from, the genus *Ceratitis* known as destructive to oranges in Madeira'—Vide *Votes and Proceedings, Queensland, 2nd Session* 1879, vol. ii., p. 985."

abdomen were noted by Tryon (Boyd 1911). The species, however, was considered for the time under *tryoni,* or as a variety of that species (records of Queensland Department of Agriculture and Stock). The banana fruit fly, *Strumeta musae* (Tryon), was not described until several years later (Tryon 1927).

Other records of W. W. Froggatt (1909) cite further variants of *tryoni* bred from fruit, chiefly tomatoes, imported from Queensland. From the description, one was most probably *S. humeralis* (Perkins), a species frequently bred from tomatoes in coastal Queensland.

Gurney (1910, 1911), although undertaking extensive commercial and wild host collections and breeding studies, recorded all Dacinae under *S. tryoni.* With our present knowledge of the group, the species bred from the wild hosts by that author was most certainly *S. halfordiae* (Tryon). These two species were confused also by Tryon (1927) when compiling his host list for *S. tryoni.*

Numerous specimens in the collection of the Queensland Department of Agriculture and Stock were bred from hosts or were taken from lure traps by Tryon at several localities in Queensland prior to 1927. Many of these were not given specific names but were grouped under *Dacus* spp. Some, including specimens bred from cultivated fruit from Springsure, 1917, and Roma, 1925, and from the wild host *Capparis mitchellii* Lindl. at Inglewood, 1915, are *S. tryoni.* Others, originally set aside by Tryon as distinct from the common species, were identified by the author as *Gymnodacus calophylli* (Perkins and May), *Neodacus* newmani* Perkins, *S. bilineata* Perkins and May, *S. breviaculeus* Hardy, *S. humeralis, S. kraussi* Hardy and *S. pallidus* Perkins and May.

The first attempt to list the species of Dacinae occurring in Queensland was made by Tryon (1927). Fifteen species were recognized, although the common solanum fly, *S. cacuminata* Hering, was recorded as *Chaetodacus dorsalis* (Hendel) and *Zeugodacus choristus* May as *Bactrocera caudatus* (Fabricius). Earlier, Jarvis (1925*a*, 1925*b*) had identified two species bred from native fruits as *Dacus cucurbitae* (most probably *Zeugodacus choristus*) and *Chaetodacus latifasciatus* Tryon and Jarvis (nomen nudum) (probably *S. bryoniae* (Tryon)).

Following Tryon's (1927) descriptions, little was done for many years to elucidate further the species occurring in eastern Australia. Jarvis (1925*a*, 1925*b*, 1926*a*, 1926*b*) had published incidental information which was covered more fully by, or incorporated in, Tryon's paper (1927). The true significance of species attacking bananas and their distribution in Queensland was studied by J. L. Froggatt (1928). Perkins (1934, 1937) added further to our knowledge by describing three new species of Dacinae from Queensland and one from Western Australia. Wright (1937), basing his identifications on information in Tryon's (1927) and Perkins' (1934) papers, cited six species occurring in New South Wales.

* See p. 41.

In recent years, Hering (1941), Perkins and May (1949), Hardy (1951) and May (1951, 1952, 1955, 1957*b*, 1962*a*, 1962*b*) have increased the number of species of Dacinae in Queensland to 54.

As new species were recognized during the author's investigations, it was soon evident that some diagnostic characters required attention, and a key for the ready identification of Dacinae occurring in Queensland was desirable. This involved a general appraisal of characters, a study of variations, particularly those concerning colour and certain structures, and in a few instances additions to and revisions of species descriptions.

Some 192,000 specimens of *S. tryoni,* with lesser numbers of other species, were taken in traps during these investigations. Comparable numbers were also bred from hosts. These provided material for taxonomic studies. Long series from live traps were excellent for descriptive purposes. Greater numbers were taken in the standard glass invaginated traps charged with ammonia-base lures. When required from this source, specimens were preserved in 70 per cent. alcohol or were dried and pinned. The specimens in alcohol, though discoloured, were used to confirm characters, estimate variation within species and provide specimens for an appraisal of wing and ovipositor characters. The method used in rearing, mounting and identifying specimens from hosts has been standardized (May 1953). Other relevant details are given under the respective headings.

When illustrating a character or its aberration, only specific names are used in the early sections. This is to avoid confusion, as an altered concept of generic classification for some species is presented and discussed in a subsequent section.

II. STUDIES OF DIAGNOSTIC CHARACTERS

The nomenclature used for species is that adopted by Shiraki (1933) and followed by Perkins (1934, 1937, 1939) and Munro (1947).

(a) Measurements

Length of body is always measured from the dorsal aspect and is the distance from the base of the antennae to the posterior margin of the fifth abdominal tergite. An explanation of the measurements of the face and frons, vertical length of the head, and several wing characters has already been given (May 1955). Those of the antennae shown diagrammatically in Figure 1 are taken as follows:—

Segment 1: From base to apex on the dorsal surface.

Segment 2: Length along lower margin when viewed laterally.

Segment 3: Length along upper margin when viewed laterally.

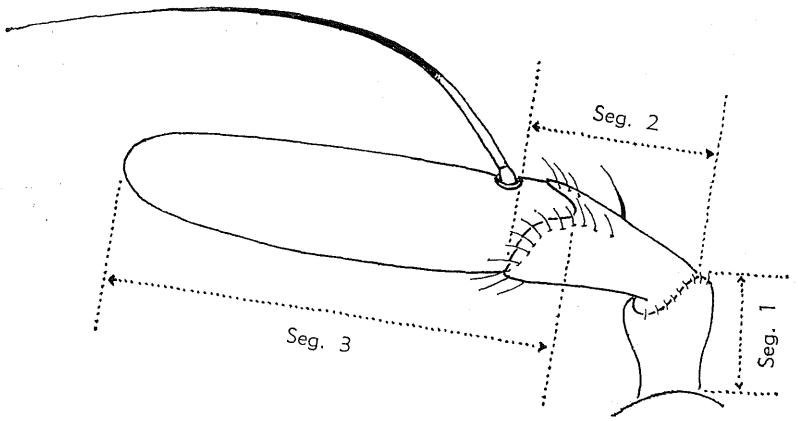


Fig. 1.—A diagrammatic representation of the lengths of antennal segments of Dacinae.

The measurements presented in Appendix 1 were taken from either the types or the plesiotypes used to revise descriptions of Queensland species. The plesiotypes have been lodged at the Queensland Museum.

(b) Size of Specimen

It is general practice to give the lengths of the body and wing of types. The accuracy of a single measurement for a species is dependent on the age as well as the disposition of the mounted specimen. Teneral specimens shrivel, while depression of the head and abdomen with respect to the thorax after pinning also prevents accurate measuring.

Sometimes a length range is given. Tryon (1927) stated that the length of body of the type female of *halfordiae* is 6·5 mm. Perkins (1934), when describing *gurneyi* (= *halfordiae*), stated that the body length ranged from 6·5 mm to 7·5 mm. Much smaller specimens of this species have been taken frequently in traps, and melanic forms measured as low as 3·9 mm. Similarly, wide ranges were evident for this and other species when large series were examined. The mean lengths, however, may approximate those for the type specimens (see May 1953, pp. 50, 61). Nevertheless, and although marked differences in general size among species are sometimes obvious, this criterion should be disregarded for identification purposes.

(c) Colour

Colour and colour patterns on the head, thorax, wing, legs and abdomen are usually basic for species (Figure 2). Though intensity of colour, and to a lesser extent colour patterns, may vary on the mesonotum, pleuron, postnotum, legs and abdomen, the colour of the scutellum and the colour and shape of the thoracic calli, vittae (or stripes) and spots and infuscation on the wing are uniform within a species. All these characters are of considerable value for species identification and are discussed in some detail in later sections.

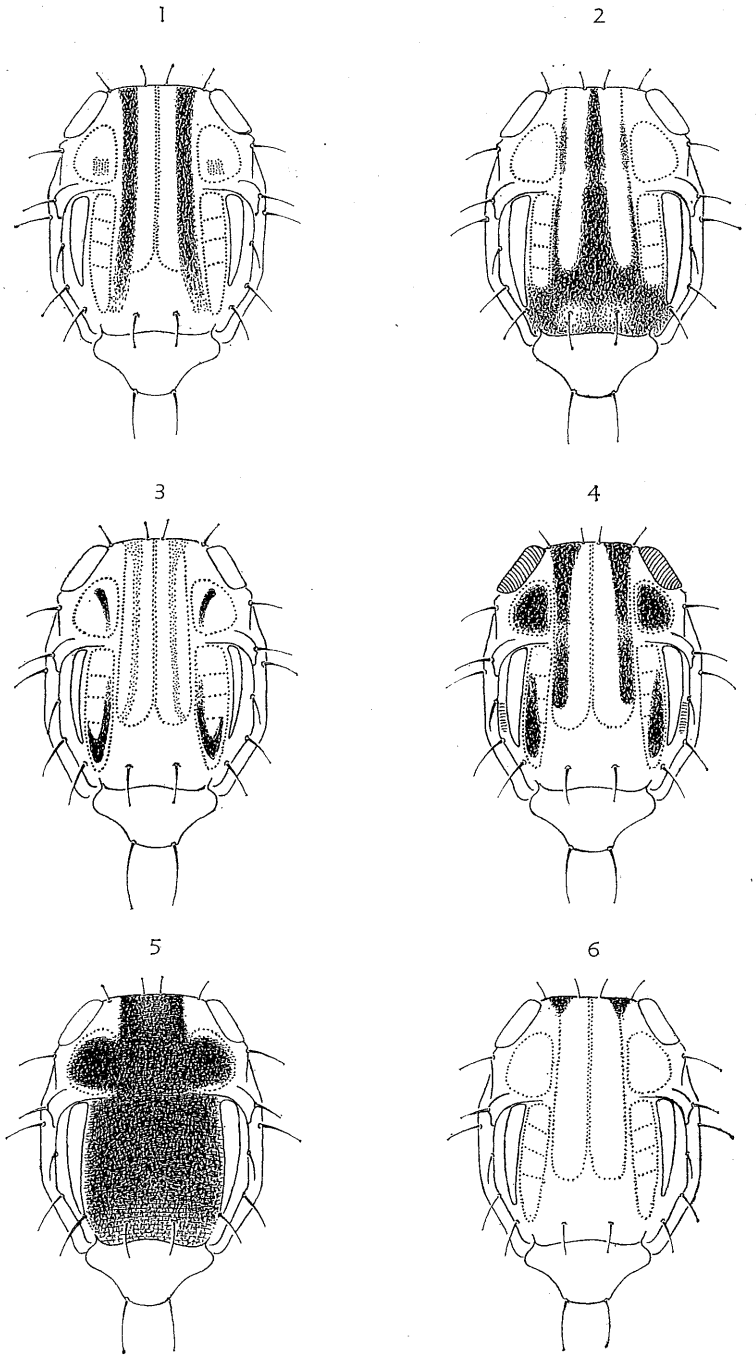


Fig. 2.—Basic colour patterns related to areas of attachment of flight muscles (shown by dotted lines) of six species of Dacinae from Queensland: (1) *Strumeta bilineata,* (2) *S. cacuminata,* (3) *S. halfordiae,* (4) *S. humeralis,* (5) *S. musae,* (6) *S. tryoni.*

Shades of colour are misleading: these vary with age of specimen both before and after capture. Teneral specimens are always paler than aged (sclerotized) field specimens of the same species and may exhibit subcutaneous markings not evident in sclerotized material. Tryon (1927) pointed out the bad features of teneral specimens, especially the subsequent loss of colour in pinned material. Unless bred specimens are allowed to age before being killed and pinned, colours subsequently fade, while calli become stained or so faded as to be indiscernible and infuscation on the wing may lighten appreciably.

The significance of melanic forms within species must be appreciated if species are to be identified correctly. Considerable variation in the development of melanin on the thorax and abdomen is evident among specimens of some species. These forms are discussed elsewhere in this paper.

(d) Characters of the Head

Apart from the markings on the face, characters of the head of Dacinae (Figure 3) are of little value for separating species. The relative lengths of segments of the antennae, length of face and frons and vertical length of the head are generic characters. These comparators have been used to separate *Callantra* Walker from all other genera (Hardy and Adachi 1954).

The shape of the frons was not considered of value for species identification in these studies. Although the shape of the frons does vary for species and is often characteristic, the ratio length:breadth does not measure this variation. Hardy (1951) suggested comparing breadth with a character of more consistent measurement, such as the ocellar triangle or eye width. Munro (1947) considered that the dimensions are best expressed by recording the width "in terms of the length and of the width of the head". Such measurement comparisons depend on the condition of the specimen.

Chaetotaxy.—The number of inferior fronto-orbital (*i.or.*) bristles may vary between species from nil to three pair and the bristles may be weak or strong. As numbers vary also within species, the value placed by some authors on the use of the number of *i.or.* bristles to separate species cannot be supported. The number and strength of bristles in the occipital row and the presence or absence of post-vertical bristles have been quoted in species descriptions. These characters are not always consistent within species. Other bristles, including the vertical (2 pairs), ocellar (1 pair, very weak), superior fronto-orbital (*s.or.*) (1 pair) and genal (1 pair), are always present. Sometimes two pairs of genal bristles are present; the second pair is abnormal. The presence and strength of the gular bristle varied among species but was not investigated. Often this bristle is weak, pale and hard to differentiate from the long hairs of the gulo-mentum.

The colour of bristles, though often quoted for species, may deepen with age of specimen before capture and is not of taxonomic value.

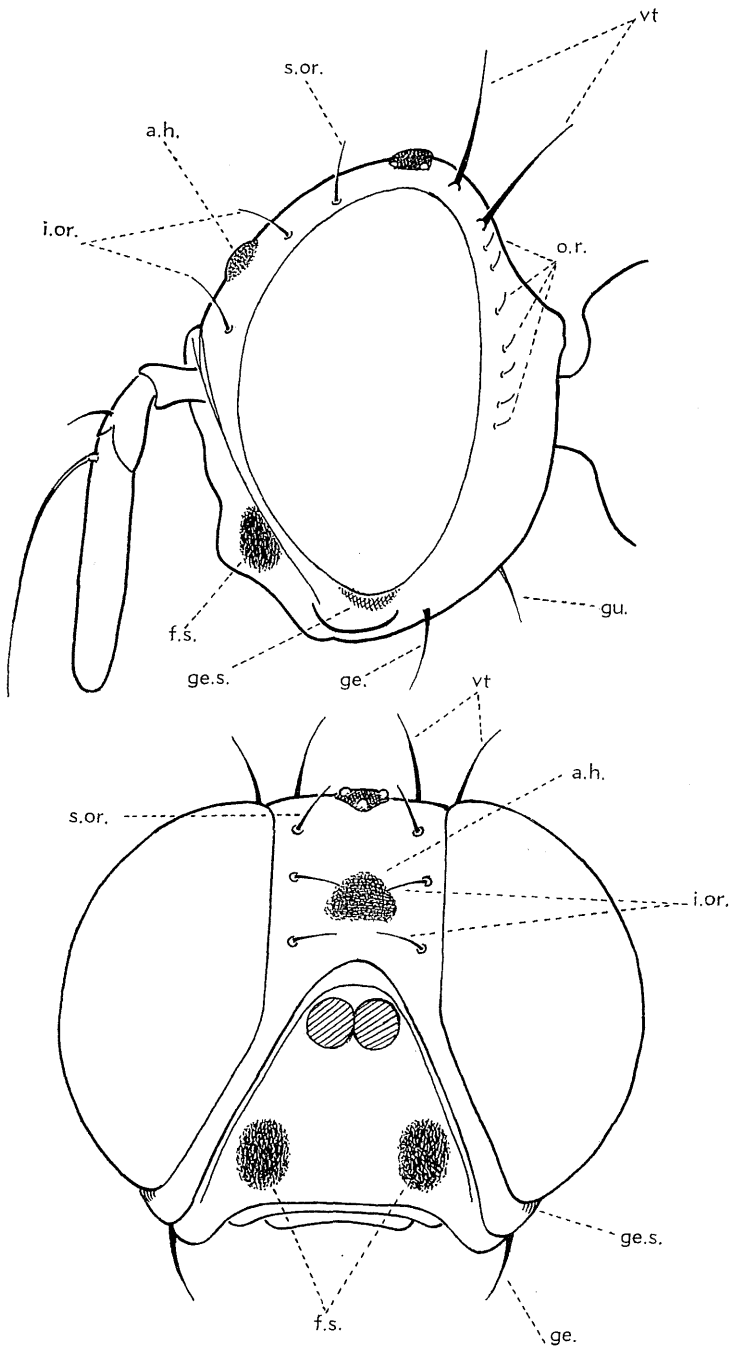


Fig. 3. Diagrammatic lateral and frontal aspect of the head of *S. tryoni* showing diagnostic characters: a.h., antero-medial hump; f.s., facial spot; ge., genal bristle; ge.s., genal spot; gu., gular bristle; i. or., inferior fronto-orbital bristles; o.r., occipital row; s.or., superior fronto-orbital bristle; vt., vertical bristles.

Facial Spot.—The presence or absence of a paired facial spot is a reliable diagnostic character although some variation occurs in *mutabilis* May (May 1951). In most species this spot exhibits only slight variation, this being in size rather than in shape. Both size and shape, however, vary markedly in *halfordiae*. Typically the spot in this species is drawn out to a point anteriorly; but within a series it may grade from distinct and comma-shaped to only a faint streak in the lower half of the antennal groove. A few specimens have no facial spot.

(e) Characters of the Thorax

Chaetotaxy.—The chaetotaxy (Figure 4) serves to differentiate certain genera (subgenera of some authors) of the Dacinae. The scapular (*scp.*), notopleural (*npl.*), posterior supra-alar (*p.sa.*), mesopleural (*mpl.*) and pteropleural (*pt.*) bristles are common to all genera, though colour and strength may vary. The anterior supra-alar (*a.sa.*) and prescutellar (*prsc.*) bristles may be present or absent, while the scutellar (*sc.*) bristles may vary from one pair to two pairs among genera, and in exceptional instances within a genus. Within a species, the numbers of *a.sa.* (e.g. *mutabilis*—see May 1951, p. 5), *prsc.* (e.g. *murrayi* Perkins, see p. 41), and *sc.* (e.g. *signatifer* Tryon, see p. 42) bristles are variable, though such variation is the exception rather than the rule. Any abnormalities among series of field specimens of species are within the limits of normal variation. Greater variation is found, usually, among series bred from hosts in the laboratory. It was concluded that the presence or absence of the *a.sa.* and *prsc.* bristles and the number of pairs of *sc.* bristles are valid characters for use in generic classification.

Calli and Vittae.—The humeral callus, usually yellow, may be fuscous on the anterior margin or be wholly brown or black. The colour is not uniform for teneral specimens, and may be pale or so discoloured that the true colour is indiscernible.

The notopleural callus, generally yellow, may also be brown or dark brown. This callus may be joined to the humeral callus by a yellow band (e.g. *jarvisi* Tryon and *strigifinis* Walker).

The lateral post-sutural vitta is important in classification. This may be present or absent, broad or narrow, parallel-sided or triangular and end before, at or after the upper *p.sa.* bristle. In some species, mainly those possessing two pairs of scutellar bristles (e.g. *choristus, cucumis* French, *expandens* Walker and *signatifer*), this stripe may be continued across the thoracic suture to form a pre-sutural spot. This spot is present also in *strigifinis,* which has one pair of scutellar bristles.

The pre-sutural stripe is triangular, yellow and lies anterior to the thoracic suture with its apex level with the inner extremity of this suture and the base either commencing on or enveloping the notopleural callus; and occurs usually

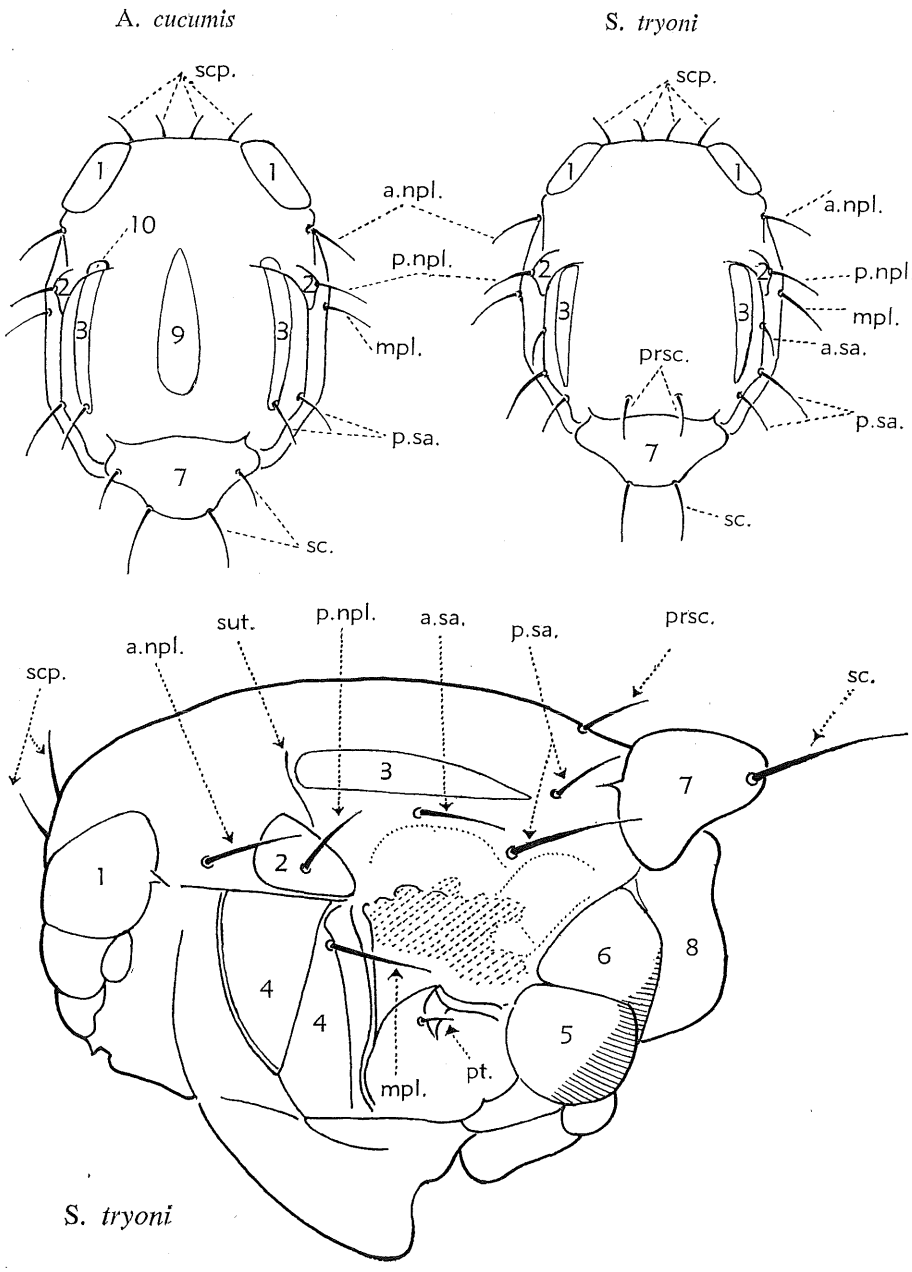


Fig. 4.—Diagrammatic dorsal (above) and lateral (below) aspects of the thorax showing diagnostic characters, other than colour, as follows:— Bristles: a.sa., anterior supra-alar; p.sa., posterior supra-alar; a.npl., anterior notopleural; p.npl., posterior notopleural; mpl., mesopleural; prsc., prescutellar; pt., pteropleural; sc., scutellar; scp., scapular. Calli and vittae: 1, humeral callus; 2, notopleural callus; 3, lateral post-sutural vitta; 4, mesopleural stripe; 5, lower hypopleural callus; 6, upper hypopleural callus; 7, scutellum; 8, postnotum; 9, medial post-sutural vitta; 10, pre-sutural spot; sut., suture.

as a continuation of the mesopleural stripe. Those species possessing a presutural stripe lack a lateral post-sutural vitta (e.g. *absonifacies* May, *aequalis* Coquillet, *auricoma* May, *exiguus* May, *mendosa* May, *newmani, niger* Tryon, *petioliforma* May and *signatifrons* May).

The medial post-sutural vitta, usually pointed anteriorly and rounded posteriorly, is yellow and commences before, at or after the thoracic suture. This stripe is of considerable value in species identification and between species varies considerably in shape, size and position. It is reduced to a small oval spot in *newmani* and is absent in all Queensland species of *Strumeta* Walker and *Callantra*. This vitta may be present or absent within a genus.

The mesoplural stripe, situated chiefly on the posterior portion of the mesopleuron and bounded above, behind and below by the notopleural, mesopleural and usually the sternopleural sutures respectively, is yellow and of uniform shape and size for species. It varies among species from narrow, parallel-sided and no wider than the notopleural callus above (e.g. *aequalis, auricoma, halfordiae* and *pulcher* Tryon) to broadly triangular, with base extending along the notopleural suture to reach the posterior margin of the humeral callus, and with the apex, truncated by the sternopleural suture, no wider than the notopleural callus (e.g. *alyxiae* May, *recurrens* Hering and *tigrinus* May). Gradations between these two extremes occur. The anterior margin may be deeply concave yet attain the humeral callus anteriorly (e.g. *brunneus* Perkins and May, *visendus* Hardy); the anterior margin may be convex and attain the anterior notopleural bristle at the notopleural suture (e.g. *calophylli, fuscatus* Perkins and May, *jarvisi* and *murrayi*); or it may be convex or straight on the anterior margin, wider than the notopleural callus above, yet not attain the anterior notopleural bristle at the notopleural suture (e.g. *cucumis, musae* and *tryoni*). When the mesopleural stripe extends across the sternopleural suture it ends in an oval spot on the upper portion of the sternopleuron. This spot may be small, narrower than the notopleural callus and at times indistinct, or it may be large, oval in shape, and considerably wider than the width of the mesopleural stripe at the sternopleural suture. The size of this spot is consistent within a species but has not been considered as a means of differentiating species.

Paired calli occur posterior to the pteropleuron and coincide in position with the hypopleuron and metapleuron. These are referred to as hypopleural calli (metapleural calli of some authors) and are yellow or whitish with varying proportions of the basal areas brown to dark brown. In *Callantra* species these may be wholly brown or centrally whitish. The relative areas of colour on these calli are characteristic of a species.

Scutellum.—The scutellum, from two to three times as wide as long, varies in shape among species or groups of species. It is short and broad for *Callantra* species but narrower and more pointed for other genera. Between the apical pair of bristles it may be rounded or flattened. For most species it is yellow with a thin dark brown or black basal band. For a few species it carries a brown,

dark brown or black spot at its apex (e.g. *aureus* May and *mesoniger* May); is coloured brown or dark brown on the apical third or half of the disc (e.g. *bancroftii* Tryon and *brunneus*); is brown or dark brown on the basal third or half of the disc (e.g. *Callantra* species, *fagraea* Tryon, *halfordiae* and *kraussi*); is brown on the medial longitudinal third of the disc (e.g. *strigatus* Perkins); or may be largely black (e.g. *niger*) or brown (e.g. *phaleriae* May).

Colour of the scutellum provides a reliable means of differentiating species. Shape was not considered in these studies, as differences among species were not sufficiently large.

Legs and Coxae.—Colour of the legs, whether yellow, fulvous, brown, dark brown or black, often is characteristic for a species, especially the colour of the coxae, femora and tibiae. These characters are more uniform and more readily discernible among recently captured field specimens. Many species have fulvous legs with the exception of the hind tibiae, which are dark brown. Other species may differ from this arrangement. Such differences are accompanied also by characters on the thorax, abdomen or wings which are used more frequently to separate the species.

The chaetotaxy of the legs exhibits little variation. Occasionally a row of spines is found beneath the front femur (e.g. *petioliforma* and *tigrinus*). Most species have two or more rows of fine bristles on the dorsal aspect of the front femora. These are usually pale and thin but may be strong and black (e.g. *bryoniae*). The middle tibia of all species has a well developed apical spine which may be brown or black.

Wing.—Wing venation differs little among Queensland species of Dacinae except for the position of the junction of the *r–m* cross vein with vein m_{1+2} and the length of the anal cell extension in relation to the length of vein $cu_1 + 1a$. These wing characters, together with the proportionate length of the second costal cell and stigma, have been used in species descriptions (May 1955) and values for the types or plesiotypes of Queensland Dacinae are tabulated in Appendix 1.

The position of the junction of the *r–m* cross vein with m_{1+2} varies between the midpoint (e.g. *recurrens*) and a point approximately four-fifths of the distance between the inner and outer median cross veins (e.g. *strigatus*). The length of the anal cell extension with respect to the length of $cu_1 + 1a$, as well as differing among species, varies between males and females of the same species. The difference exhibited between the sexes is proportionate to the extent of development of the supernumerary lobe in the male.

The validity of wing measurements for differentiating species is open to question, as considerable variation was evident within species. The significance of this variation is discussed in a later section.

The presence of setae on the veins has been recorded by other authors. This character was examined, but with the exception of the upper surface of vein r_{4+5}, the arrangement of setae on the upper or lower surface of longitudinal veins showed little variation among species. For most species, the setae on the upper surace of vein r_{4+5} extend from its base to a point where this vein makes a slight undulation, approximately half the distance between its junction with the *r–m* cross vein and the wing margin. Occasionally the setae may extend a short distance past this undulation in r_{4+5} (e.g. *alyxiae, aureus* and *petioliforma*); may extend almost half way between the undulation in r_{4+5} and the wing margin (e.g. *strigifinis* and *visendus*); or almost attain the wing margin (e.g. *signatifer*). These setae may be long and strongly developed (e.g. *cucumis* and *hispidula* May).

All veins are uniformly coloured and exhibit little variation among species.

A bulla is present on the cubital vein towards the apex of the anal cell extension in the male of some species of Queensland *Afrodacus* Bezzi (e.g. *furvus* May and *tigrinus*). It is most probable that a bulla will be found also on the wing of *flavinotus* May when the male has been taken.

The shape of the wing differs considerably among species and may be between 2·5 and 3 times as long as broad. The significance of this variation was not investigated.

Considerable difference occurs among species in the extent of infuscation present and also the general colour of the wing-membrane. Usually, the wing-membrane is hyaline, although aged field specimens of many species exhibit a general brownish discolouration. This is particularly evident with *expandens, fagraea, halfordiae* and *kraussi* and is common also to Queensland species of *Callantra.*

Infuscation may occur on the wing as a costal band, as an anal streak and in distinct patterns over the wing-membrane distal to the second basal cell. The costal band which continues along the costa from the stigma to end at or beyond the apex of the wing may be entire and either narrow or broad; may be interrupted in the middle; may be parallel-sided beyond the tip of r_{2+3}; or may thicken at its extremity, in some instances, to form a broad apical spot. This band may be very narrow and faint or lacking altogether (e.g. *niger*). The anal streak usually covers the anal cell and extends at even width beyond this cell, anterior to the anal cell extension, but narrows as it approaches the wing margin. This streak may be broad and attain the wing margin; may be narrow and short; or may be absent altogether. The shape and colour of the anal streak are of doubtful value for species identification, as the streak is often imperceptible among teneral specimens.

Areas of infuscation over the wing-membrane, other than the costal band and anal streak, may enclose only the *r-m* and/or *Im* cross veins; may be more extensive and represent transverse bands or patterns across the centre of the

wing; or may merely occur as discolourations in the distal portions of the discal cell or towards the extremity of the fifth longitudinal vein (m_{3+4}). These patterns of infuscation are characteristic for a species and are intense for indurated specimens, but may not be of uniform density for teneral specimens, especially near the wing margin between the longitudinal veins.

The colour of the costal cells may range among species from colourless in one or both cells to brown in both cells. Gradation of colour has been used to separate species but is unreliable. Teneral specimens of a species may exhibit colourless costal cells which may be fumose, pale fulvous or even fulvous in sclerotized specimens of the same species.

The presence or absence and density of microtrichia in the costal cells were considered first by Hardy (1951) to distinguish species. The proportion of the first and second costal cells covered with microtrichia can provide a reliable measure for separating groups of species. Microtrichia may occur in the upper outer portion of the second costal cell while the basal portion of this cell and the first costal cell may be clear. In such instances the cells are colourless, pale fulvous or rarely fulvous. Other species possess microtrichia over most of the second costal cell and a varying portion of the first costal cell. The cells are coloured brown.

Aggregations of microtrichia are found also immediately above the second basal cell and, in males of some species, at the extremity of the fifth longitudinal vein ($cu_1 + 1a$). This latter aggregation may be accompanied by an increase in length of the fine hairs covering the undersurface of the anal cell extension and is a sex character, linked with mating behaviour. Males of species exhibiting an aggregation of microtrichia at the extremity of vein $cu_1 + 1a$ also possess a pecten of hairs on the third abdominal tergite.

The extent of development of the supernumerary lobe is variable within a genus. It may vary from a strongly developed lobe (e.g. *bancroftii, choristus* and *tryoni*) to a weakly developed lobe (e.g. *breviaculeus* and *mutabilis*). It is weakly developed in most Queensland species of *Strumeta.* Specimens of *calophylli* and *niger* exhibit variation from no lobe to a weakly developed lobe.

The presence or absence of a supernumerary lobe in the male has been used by authors to designate genera (or sub-genera). Some have been erected solely on this character (*Apodacus* Perkins, *Heterodaculus* Hardy, *Melanodacus* Perkins, *Neodacus* Perkins and *Parazeugodacus* Shiraki) and many of these are monotypic. Genera (or subgenera) so erected should be considered as synonyms unless other distinguishing characters can be found. This character is of no more than specific rank although it has not been used to designate species.

(f) Characters of the Abdomen

The conformation, shape, colour and male and female sex characters provide means of differentiating species and even genera of Dacinae.

The tergites of six species of Queensland Dacinae (viz. *absonifacies, aequalis, auricoma, newmani, petioliforma* and *signatifrons*) are fused (Figure 5). The tergites of all other species of Queensland Dacinae are free and articulated with the exception of the first two tergites in both sexes, which are fused. Fusion or non-fusion of tergites is a generic character and is discussed in more detail on page 36.

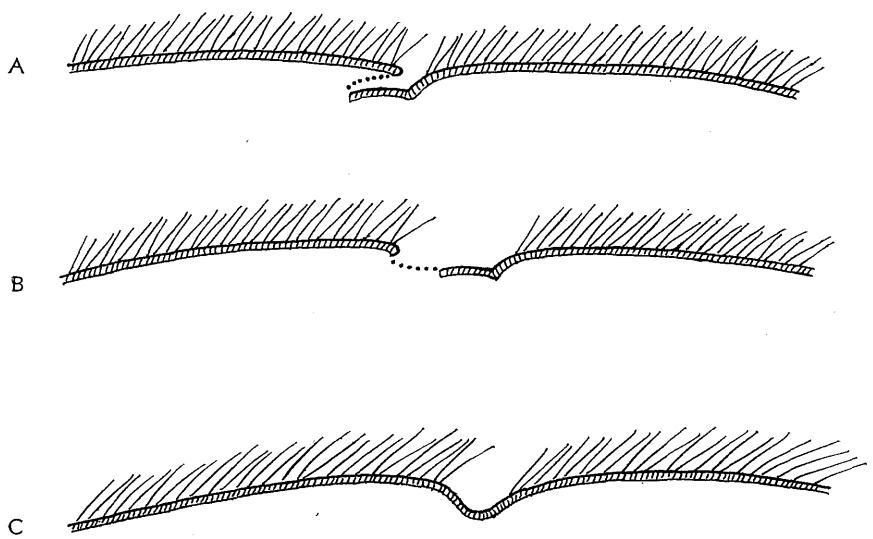


Fig. 5.—Diagrammatic cross-sections of a portion of the abdomen of Dacinae with (A) non-fused and (C) fused tergites. Non-fused tergites are free to articulate (B).

The general shape of the abdomen also is used to differentiate genera (Figure 6). In *Callantra,* the first tergite is longer than wide and may be parallel-sided or narrower at its posterior margin. For other genera, the reverse is true. Also, the abdomen of *Callantra* species is elongate, petiolate and strongly clavate, being widest on a line level with the posterior margin of the fourth tergite. For other species of Queensland Dacinae, the abdomen is oval or rounded, not elongated, and is widest along a line through the anterior (sometimes posterior) margin of the third tergite. In lateral aspect, the shape of the abdomen is characteristic for all Australian species of *Callantra,* being strongly arched posteriorly, reaching its highest point at or behind the junction of the third and fourth tergites. Also, the fifth tergite is at least as long as the fourth measured laterally and is square on its hind margin. In other Australian Dacinae, the abdomen is arched centrally, being highest towards the anterior margin of the third tergite, while the fifth tergite is rounded posteriorly and is much shorter than the fourth.

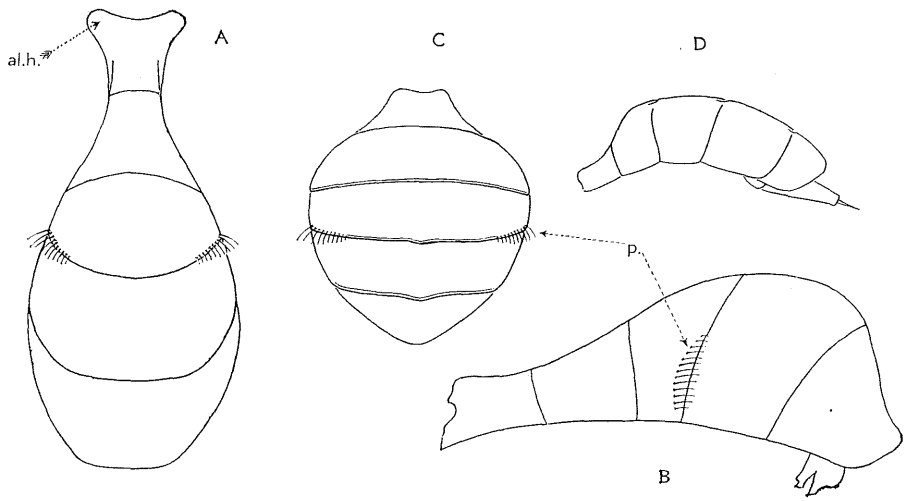


Fig. 6.—Diagrammatic dorsal and lateral aspects of the abdomen of *Callantra aequalis* male (A and B) and *Strumeta tryoni* male (C) and female (D) exhibiting the relative shapes, disposition of sutures and the following diagnostic characters:—al.h., antero-lateral hump; p., pecten.

The shape of the suture between the third and fourth tergites reflects the shape of the abdomen in lateral aspect. In *Callantra* species this suture is strongly concave forwards. In other Dacinae, it is only slightly concave forwards, or is more usually straight or weakly convex forwards.

The antero-lateral humps on the first abdominal tergite are developed strongly in *absonifacies* and *Callantra* species, but are less evident in *newmani* and *signatifrons*. These are not prominent in other Australian species.

Colour and patterns of colour on the abdomen of teneral specimens and melanic forms may exhibit considerable variation from the norm of a species and are discussed in a later section.

Among normal indurated specimens, colour of the abdomen is specific and may be uniform or exhibit fuscous markings on a paler background. Fuscous markings are more usually found on the lateral margins of the last three tergites, on the anterior margin of the third, medially on the second and over most of the first tergite. These fuscous areas may expand until the tergites are mostly dark brown or black; or lessen until only the extreme lateral margins of the last three tergites are fuscous and the remainder of the tergites are fulvous, orange, orange-brown or reddish-brown. A broad or narrow, brown, fuscous or black medial vitta often is present on the last three tergites. This may be contracted to an oval black spot on the fifth tergite (e.g. *signatifer*) or extended to form a band running the entire length of the abdomen (e.g. *aureus*). Paired shining spots occur on the fifth tergite and may be pale and inconspicuous or brown to black and characteristic for species (e.g. *halfordiae* and *kraussi*).

A pecten or comb of hairs may be found on the posterior lateral margin of the third tergite of the male of some species. This character is uniform and is used to distinguish genera. It was not possible to relate consistent female characters with the presence or absence of the pecten in the male of the species.

Characters of the ovipositor have been used to supplement species descriptions (Hardy 1951) and designate species (Hardy and Adachi 1954). The basal segment or visible portion is often a useful guide to species and may be very short (e.g. *barringtoniae* Tryon and *breviaculeus*), very elongate (e.g. *fagraea*), cylindrical (e.g. *Callantra* species) or compressed dorso-ventrally as in other genera. A complete reliance on ovipositor characters for species identification was not considered justified (see p. 30).

III. SPECIES VARIATIONS

(a) Colour

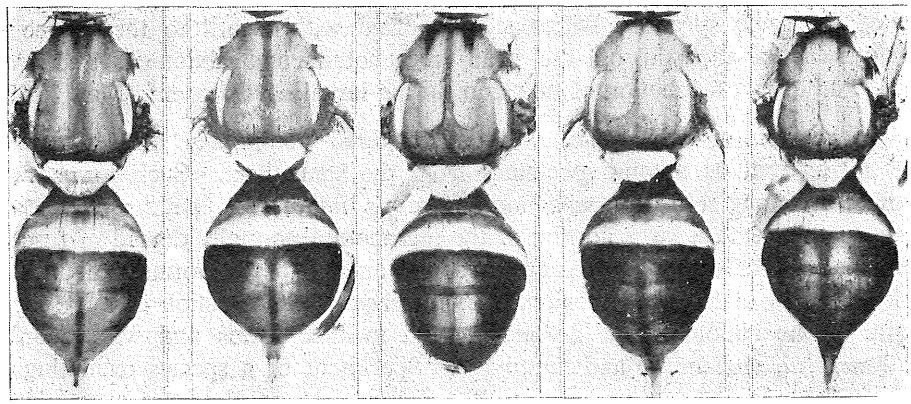
Examination and identification of large series of specimens taken from traps or bred from hosts revealed that variation in colour on the thorax and abdomen was associated with age of specimen when captured and host. These colour forms and associations were investigated.

Colour Due to Age.—Changes in colour pattern and colour intensity on the mesonotum and abdomen, irrespective of species, follow a definite sequence as newly emerged flies age. The most pronounced colour change, apart from sclerotization of the cuticle and a general darkening in colour, is that exhibited by a continuing alteration in subcutaneous markings, most probably in the hypodermal layer, on the central portion of the mesonotum. This is more discernible for those species not intensely pigmented on the dorsal surface and is seen more clearly when specimens are examined in alcohol or water. For those species largely dark brown or black on the thorax, changes are evident merely in the areas and intensity of pigmentation.

No attempt was made to determine the morphological changes in subcutaneous layers associated with ageing of individuals. The sequence of change for *tryoni* from a newly emerged fly to an indurated specimen was photographed and is illustrated at various stages in the colour progression in Figure 7 and discussed below.

Newly emerged flies of *tryoni,* apart from their pale colour, possess a broad semi-transparent medial band on the mesonotum (Figure 7, Stage 1) which may extend into the scutellum and be visible also through the abdominal tergites. This corresponds in length and breadth with the position of the dorsal vessel and represents a space between the right and left longitudinal flight muscles. It is a consistent feature of teneral flies and has been featured in species descriptions. As flies age and colour deepens, this band narrows anteriorly on the mesonotum and at the same time a thin line

of melanin is deposited along each inner edge (Figure 7, Stage 2). The band continues to narrow progressively from the anterior edge backwards, the black lines at the same time meeting firstly at their anterior ends (Figure 7, Stage 3), and eventually coalescing for their entire length (Figure 7, Stage 4). The end point is a narrow black medial line on the mesonotum, commencing at the anterior edge and extending backwards until level with the posterior end of the lateral post-sutural stripes, then branching to curve outwards and forwards and end at each suture. Thin black lines may connect each lateral post-sutural yellow stripe to these outer longitudinal lines (Figure 7, Stage 5). The fine black or dark brown lines represent a deposition of melanin between the areas of attachment of flight muscles and are common to all species (see Figure 2).



Stage 1 Stage 2 Stage 3 Stage 4 Stage 5

Fig. 7.—Progressive changes in colour pattern and colour intensity on the dorsum of *Strumeta tryoni* associated with ageing from teneral (at left) to indurated (at right) individuals.

In association with these altering patterns and an intensification of colour on the mesonotum of *tryoni,* colour changes occur on the tergites. The central half of the third, fourth and fifth tergites of teneral flies is uniformly pale fulvous except for a faint median longitudinal fuscous band; the remainder is fuscous (Figure 7, Stage 1). With age, the pale fulvous areas darken until the abdomen posterior to the second tergite is fuscous except for a small slightly paler area in the central portions of each tergite, lateral to the often indiscernible median longitudinal band.

This sequence of changes on the thorax and abdomen can be traced in all species and may be prolonged considerably during periods of low temperature.

Species that exhibit an extensive black pattern on the mesonotum of indurated field specimens may when teneral exhibit only limited areas of melanin on the mesonotum. These areas are cutaneous and can be related to the areas of attachment of the dorsoventral and longitudinal muscles (see Figure 2).

Teneral material of species heavily pigmented with melanin on the mesonotum (*bancroftii, endiandrae* Perkins and May and *musae*) are black (or dark brown) only in the regions of attachment of the muscles (Figure 2). With age, remaining areas of the mesonotum darken until the greater part is black.

Species only partly black or that exhibit a pattern of longitudinal black bands on the mesonotum (*bilineata, cacuminata, halfordiae* and *humeralis*) exhibit black areas chiefly between the areas of attachment of the muscles or along the margins only of these areas (Figure 2). These bands, also, may thicken as the flies become sclerotized.

Influence of Host.—In contrast to colour changes associated with sclerotization of the cuticle, colour variation was evident among field material of similar age of the same species. Differences occurred with regard to the degree of development of melanin on the head, mesonotum and abdomen, and were considered chiefly a function of nutrition during larval development (May 1953).

Melanic forms of species were encountered continually among trapped material as well as among specimens from the same host. Such forms were recognized among series of *cacuminata, cucumis, halfordiae, jarvisi, pallidus* and *tryoni,* species with a large portion of the mesonotum normally devoid of fuscous markings. Melanic forms were not recognized among species normally pigmented dark brown or black in this region. An increase in pigmentation on the second tergite of the abdomen was associated with melanic forms and was recorded for *bancroftii, endiandrae* and *mesoniger.* Specimens of a species exhibiting an increase in areas of pigmentation on the mesonotum or abdomen were always smaller than the normal form.

As these studies progressed it became increasingly evident that melanic forms of *tryoni* were associated more frequently with a particular host whether infested in the field or by the species held as pure colonies in laboratory cages. Melanic forms were encountered also among trapped material of this species from the same locality, and were commoner in traps during late autumn, winter and spring months at Lawes (Figure 8) and Stanthorpe. This phenomenon had not been recorded previously nor was its significance completely understood.

The status of melanic forms warranted investigation from both the taxonomic and host viewpoints. Varietal names (Tryon 1927) had been accepted for these forms by workers in Queensland and were referred to in the literature (Perkins 1937; Perkins and May 1949; Hardy 1951). Hardy (1951) and others often were confused by their presence among specimens of *tryoni* bred from the same host and erroneously considered these either *humeralis* or *melas* Perkins and May.

Six arbitrary stages of melanin formation were recognized among a long series of *tryoni,* ranging from the normal form (Stage A) to the extreme melanic form (Stage F). These stages are shown in Figure 9. Melanic forms of other species were not included in this study. These are merely described under the respective species elsewhere in this paper.

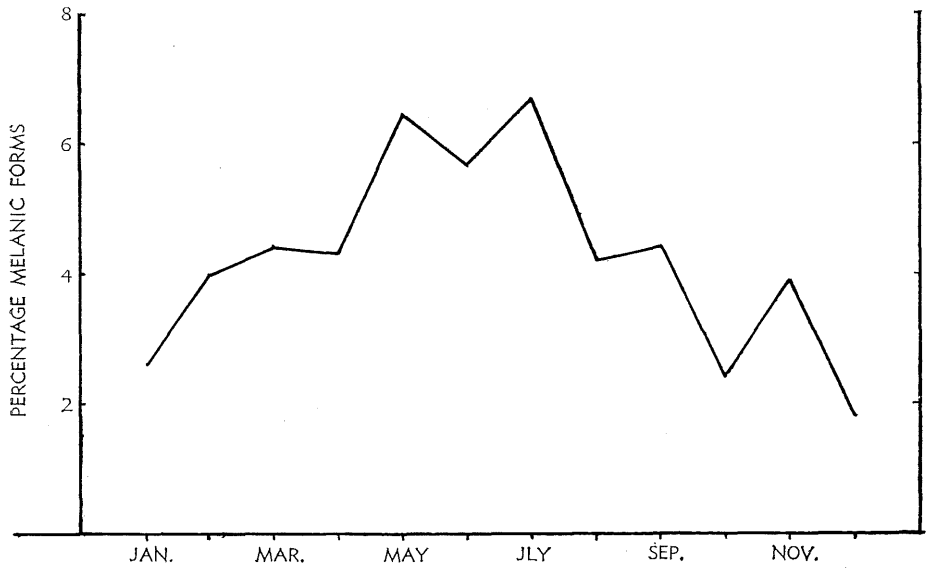


Fig. 8.—Monthly percentages of *Strumeta tryoni* melanic forms recorded at Lawes, 1950-1952.

Specimens of *tryoni* bred from 22 commercial, ornamental and wild hosts, infested in the field, and involving 30 host samples, were held in cages for a short period after emergence to allow sclerotization, and then killed, pinned and examined. Fruit samples were either collected from the ground beneath trees or were picked in an advanced stage of maturity from the plants. In all instances, larval development was well advanced. The six stages were segregated in all series and specimens were measured to correlate size and extent of melanin development. Size was expressed as the length of the mesonotum in terms of divisions of an eyepiece micrometer.

The frequency of occurrence of each stage within series is presented in Table 1. The association between size and extent of melanin development is shown in Table 2. The number of specimens measured within each stage corresponds with the number presented for the corresponding host in Table 1. The results explain the melanic forms encountered among a wild population of *tryoni*. An association between melanin formation and larval development within the host is evident.

Some fruit, including apricot, peach, plum, mulberry and tomato, always gave rise to large flies exhibiting little evidence of melanin formation. Others, especially late-season apples, quince and walnut, and a greater proportion of the wild hosts listed gave rise to smaller flies showing considerable melanin formation. Individuals exhibiting extreme melanin formation were small and almost half the size of those bred from apricots and tomatoes. This association between host and melanin formation was confirmed when specimens of *tryoni* bred from tomato and apple infested in the laboratory were examined.

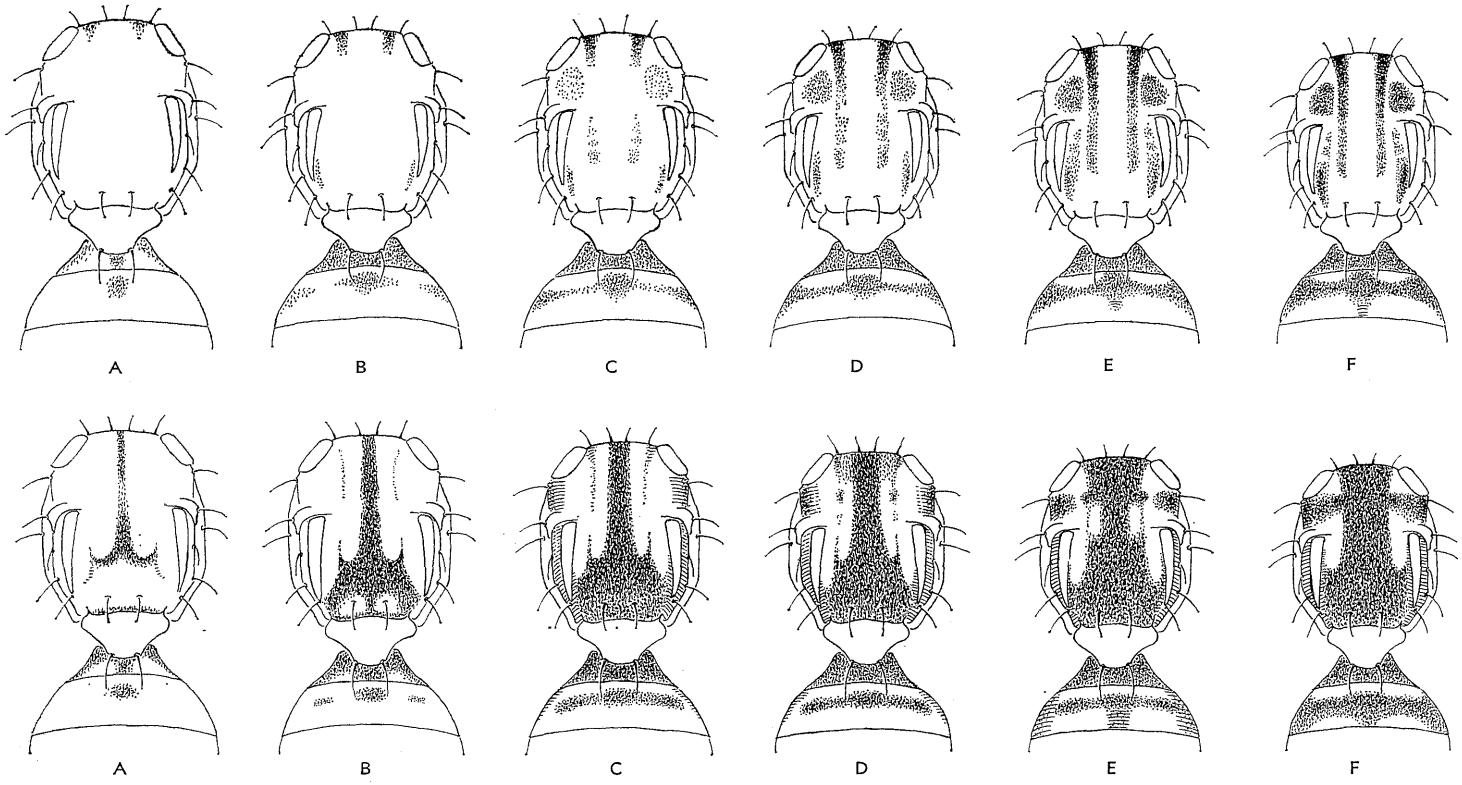


Fig. 9.—Sequence of stages in melanin formation from the normal form (Stage A, at left) to the extreme melanic form (Stage F, at right) in *Strumeta tryoni* (above) and *S. cacuminata* (below).

TABLE 1

MELANIC FORMS OF *tryoni* BRED FROM DIFFERENT HOSTS

Host	Date Collected	Number of Each Stage Recorded					
		A	B	C	D	E	F
Commercial:							
Apple (*Malus sylvestris* Mill.) ..	3. iv. 51	1	1	1	3	3	8
	26. iv. 50	2	3	2	..	..	3
Apricot (*Prunus armeniaca* L.)	14. xi. 49	59	4				
Kumquat (*Fortunella japonica* (Thunb.) Swingle)	5. x. 49	22	13	10	1		
Fig (*Ficus carica* L.)	4. iii. 51	3	1	1	..	..	2
Loquat (*Eriobotrya japonica* (Thunb.) Lindl.)	13. ix. 49	200	66	29	39	36	19
Mandarin (*Citrus reticulata* Blanco) ..	10. vii. 51	10	1	6	..	..	2
Mulberry (*Morus nigra* L.)	7. x. 49	71	20	7	1	1	
Peach (*Prunus persica* (L.) Batsch)	21. xi. 49	45					
	8. ii. 51	4	1	..	2	3	5
Plum (*Prunus domestica* L.)	14. xi. 49	11					
Quince (*Cydonia oblonga* Mill.) ..	22. ii. 50	23	21	13	8	16	7
	26. ii. 51	13	9	2	7	16	9
Tomato (*Lycopersicon esculentum* Mill.)	26. ii. 51	15					
Walnut (*Juglans regia* L.)	28. iii. 51	..	1	2	1	..	12
Ornamental:							
Eugenia uniflora L.	5. xii. 49	29	2				
Spondias cytherea Sonn...	26. vii. 51	17	7	2			
Wild:							
Cudrania javanensis Trécul ..	19. i. 50	17	1				
	22. ii. 50	17	2				
Hemicyclia australasica Muell. Arg. ..	10. ii. 50	25	12	19	2	6	11
Passiflora alba Link & Otto	13. ii. 51	2	1	..	..	..	2
Psidium guajava L.	16. iii. 50	57	24	7	1	..	2
	20. iii. 50	167	97	84	16	17	24
	30. iii. 50	31	18	6			
Rauwenhoffia leichhardtii (F. Muell.) Diels	10. ii. 50	8	3	4			
	24. ii. 50	4	4	..	..	1	
Rubus fruticosus L.	22. ii. 50	22	4	5			
Solanum seaforthianum Andr.	2. iv. 51	7	2	2	2	6	19
Terminalia muelleri Benth. ..	30. vii. 51	14	3	2	1	..	1
	27. viii. 51	16	6	3	..	5	12

In general, the mean size of individuals decreased with an increase in melanin formation (Table 2). In some instances the mean for a particular stage was inconsistent with other values in the sequence for that host. This often occurred when numbers were small. However, the genereal mean confirmed the tendency.

Cordier (1928) stated: "The production of melanin is sometimes regarded as a mechanism for disposing of toxic phenols arising as breakdown products in metabolism." Narayanan, Angalet, Subba Rao, and D'Souza (1954), when investigating variation among laboratory-reared adults of *Microbracon brevicornis*

TABLE 2

RELATIONSHIP BETWEEN SIZE AND MELANIN DEVELOPMENT IN *tryoni* FROM DIFFERENT HOSTS

Host	Size (with Range) of each Stage of Melanin Formation					
	A	B	C	D	E	F
Commercial:						
Apricot ..	23·28 (20·5–25)	22·1 (19·5–23)				
Peach ..	21·75 (20·5–23)	22·5 (22·5)	.. ..	20·75 (20–21·5)	* ..	20·6 (19–22)
Quince ..	19·8 (16–22)	18·4 (17–20)	17·9 (16·5–21)	20·06 (19–21·5)	18·28 (16·5–20)	17·2 (15–19)
Quince ..	20·7 (19–22)	19·68 (16–21)	19·5 (19·5)	18·6 (17–20)	18·75 (17–21)	17·0 (14–19)
Kumquat	21·9 (19–24)	21·76 (20–24)	21·05 (20–22)	19 (19)		
Mulberry	23·2 (21–25)	22·45 (20–24·5)	22·28 (19·5–24·5)	19·5 (19·5)	20 (20)	
Tomato ..	24·08 (23–25·5)					
Wild:						
Hemicyclia australasica	22·42 (20–24)	21·58 (20–24)	21·23 (18–23·5)	20·75 (20·5–21)	20·58 (18–22)	18·5 (17·5–20)
Psidium guajava	22·33 (19·5–24)	21·95 (20–24·5)	21·09 (19·5–24)	21·25 (20–22·5)	21·5 (19·5–23)	20·25 (20–24)
Terminalia muelleri	21·28 (19·5–23)	20·5 (20·5)	20·5 (20–21)	20·5 (20·5)	.. ..	20 (20)
Terminalia muelleri	21·53 (19·5–23·5)	20·08 (19–21·5)	19 (18–20)	.. ..	18·6 (17–20·5)	17·75 (16–19·5)
General Mean ..	22·34	21·19	20·59	20·1	19·2	18·35
No. Measured ..	315	134	79	24	51	50
General Range ..	16–25·5	16–24·5	16·5–24·5	17–22·5	16·5–23	14–22

* Data not recorded

Wesm., concluded that the development of dark pigmentation was a physiological phenomenon caused by the inability of cells to dispose of the breakdown products of metabolism in chilled pupae at low temperature. These products tended to increase and accumulate as the period of refrigeration extended. Genieys (1922), Schlotte (1926) and Kuhn (1927) had shown that dark pigmentation in *M. brevicornis* increased as temperature decreased in the field and became dominant at low temperatures.

Investigation of a relationship between low temperature and melanin development was not the purpose of these studies. Flies bred from early-maturing deciduous fruits and most commercial hosts fruiting before midsummer were usually devoid of extreme melanin development. The wild hosts *Cudrania javanensis, Rauwenhoffia leichhardtii* and *Rubus fruticosus* fruit during midsummer months.

Melanic forms were associated more frequently with hosts that ripened in the late summer and autumn, e.g. apple, quince, walnut and the wild hosts *Hemicyclia australasica, Psidium guajava* and *Solanum seaforthianum.* Temperature alone does not explain the extreme development of melanin associated with flies that breed in quince and walnut. Hosts maturing in late winter and early spring, such as kumquat, loquat, mulberry and *Terminalia muelleri,* also produced flies exhibiting extreme melanin formation.

From this evidence, a relationship is suggested between temperature and melanin formation. Inconsistencies occur, however, while some hosts fruiting in autumn and early spring were collected from localities where temperatures were not extreme and development of larvae in the fruit before the host was collected was not greatly prolonged.

The data reveal also that final instar larvae from some hosts are much reduced in size (Table 2). Size varied also between hosts within each level of melanin formation. This effect was equally evident for the normally coloured individuals (Figure 9, Stage A).

These findings do not explain the relationship between species (or subspecies) separated on colour alone, such as *barringtoniae* and *breviaculeus, halfordiae* and *kraussi, tryoni* and *melas* (and *humeralis* to a lesser extent), or the marked differences in colour intensity evident between specimens of *s. strigifinis* from North Queensland and New Guinea, *breviaculeus* from Byfield and Cairns, *pallidus* from Queensland and Western Australia, and *silvicola* May from Byfield and Atherton.

(b) Measurements

Characters, expressed as measurements or ratios, used by authors in species descriptions (Perkins 1939; Hardy 1951; May 1955) convey small but obvious variation about a norm. These characters are concerned chiefly with portions of the wing, head and ovipositor. A limited statistical study of the variation encountered among series of measurements of portions of the wing and ovipositor of *tryoni,* and other species, was undertaken to ascertain limitations in this method of species determination.

Wing Characters.—Specimens of *tryoni* from traps at Stanthorpe, Gatton, Rockhampton and Atherton and of *bryoniae* from a bulk series were used to study variations in wing characters. In each instance, measurements were taken from the right wings of 50 females viewed from above.

Eleven measurements were taken (see Figure 10), each representing the shortest distance between the mid-points of vein junctions or the extremities of veins. The results were expressed as a series of ratios to overcome variation in size between specimens. Those examined were (a) 1/2; (b) 8/9; (c) 10/11;

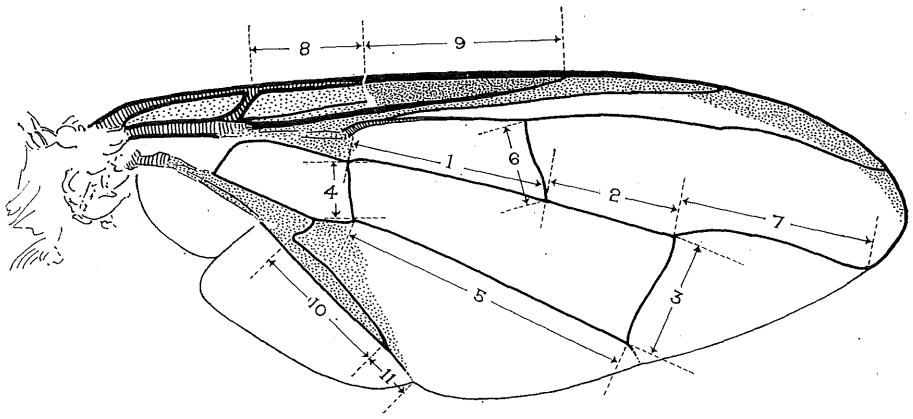


Fig. 10.—Wing of *Strumeta tryoni* showing where measurements were taken.

(d) $\frac{1+2+7}{4+6+10+11}$ (this being taken to approximate length of wing / approximate width of wing); and (e) the function $3/4 - b \times 10/11$. The numbers used in each ratio refer to a portion of the wing as shown in Figure 10. Means and ranges for each ratio were calculated for species and locality. A discriminant analysis of the results for the two species was undertaken. The ratios 1/2, 8/9, 10/11 have been used previously (May 1955). The remainder were selected as alternative ratios. Other measurements and ratios were examined (see Figure 10), but these had no better value for comparison purposes and were discarded. The results of measurements, expressed as ratios, are presented in Table 3. Lower case letters in column headings refer to the ratios listed above. None of the ratios examined were particularly effective as discriminants due to the relatively large overlap between the two species. The ratio 10/11 showed a tendency to separate the two species. The point of discrimination ($= \frac{x_2 + x_1}{2}$, where x_2 and x_1 are the means of the two species) is 1·51. Those flies having $10/11 < 1{\cdot}51$ would be classed as *bryoniae* and those having $10/11 > 1.51$ would be *tryoni*. In fact, 18 per cent. of *bryoniae* would be miscalculations as these had a value greater than 1·51.

TABLE 3

RATIOS BETWEEN LENGTHS OF RELATED PORTIONS IN THE WINGS OF TWO SPECIES OF DACINAE

Species		Ratio				
		(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
tryoni	Mean	1·54	0·63	1·67	1·56	0·40
	Range (95%)	1·30–1·78	0·55–0·71	1·30–2·04	1·44–1·68	0·04–0·77
bryoniae	Mean	1·50	0·63	1·36	1·60	0·82
	Range (95%)	1·26–1·74	0·55–0·71	0·99–1·73	1·48–1·72	0·46–1·19
Average s.e.	..	0·125	0·041	0·187	0·060	0·187

In an attempt to find a better discriminator, the function $3/4 - b \times 10/11$ was examined. It was found that $b = \cdot 87$ gave maximum discrimination. With this value of b, the separating value of the discriminant was $\cdot 61$, the proportion of miscalculations being 13 per cent.

When values for *tryoni* from four districts were compared, the validity of using these several ratios as diagnostic characters for species can be appreciated more clearly. The ratios 1/2, 8/9, 10/11 and $\frac{1+2+7}{4+6+10+11}$ were examined. The results are presented in Table 4. No significant differences were found between districts for the ratios 10/11 and $\frac{1+2+7}{4+6+10+11}$. Significant differences were found for the ratios 1/2 and 8/9. Differences were small and their practical significance would need to be determined from a more detailed examination of closely related individuals. From an analysis of variance it was obvious that to estimate adequately the range of a ratio for a particular species, at least 50 measurements of each character would have to be made (Table 5). This amount of detail is impractical unless a detailed study is being made of a group of species. Even then, a uniform source of material would be required if comparisons were to be drawn on wing measurements alone.

TABLE 4

VARIATION BETWEEN RATIOS OF MEASUREMENTS FROM THE WING OF *tryoni* FROM FOUR DISTRICTS

District	Ratios			
	1/2	8/9	10/11	$\frac{1+2+7}{4+6+10+11}$
1. Rockhampton	1·58	·605	1·65	1·53
2. Stanthorpe	1·58	·631	1·71	1·56
3. Gatton	1·54	·616	1·62	1·55
4. Atherton	1·49	·644	1·69	1·54
General Mean	1·54	·628	1·67	1·56
	1, 2>>4 3>4	1, 4>>1 4>>3 2>3	No significant differences	F not significant No significant differences

>=significantly greater than at 5% level

>>=significantly greater than at 1% level

The limitations to the use of wing measurements (or ratios of measurements) are obvious. The data presented in Table 5 bear comparison with the values presented in Appendix 1 for the same species but calculated from a single specimen. At most, wing measurements should serve merely to supplement descriptions. Outstanding values were noted for the ratios 1/2 and 10/11 when all Queensland species were examined (Appendix 1). These species can be separated on other more consistent characters.

TABLE 5

MEAN OF TWO RATIOS FOR FOUR SPECIES OF DACINAE

Species		No. Measured	1/2		10/11	
			Mean	s.e.	Mean	s.e.
jarvisi	♀	50	1·54±0·117	0·017	1·50±0·149	0·021
jarvisi	♂	50	1·57±0·098	0·014	2·84±0·269	0·038
bilineata	♀	25	1·45±0·107	0·021	1·53±0·158	0·030
bilineata	♂	25	1·43±0·125	0·025	2·78±0·187	0·037
cacuminata	♀	50	1·63±0·115	0·016	1·12±0·072	0·010
cacuminata	♂	50	1·57±0·109	0·015	2·34±0·208	0·029
pallidus	♀	50	1·63±0·077	0·011	1·05±0·074	0·010
pallidus	♂	50	1·62±0·106	0·015	2·28±·177	0·025

Ovipositor Characters.—Hardy (1951) and Hardy and Adachi (1954) laid stress on the value of measurements and characters of portions of the ovipositor to discriminate species. For many species, differences, chiefly in overall length, are obvious. The validity of using linear measurements of the ovipositor to distinguish species, in general, is open to question. In many instances, differences are small and may be nullified by normal variation within the species under comparison.

Material for this study comprised either field specimens from districts or specimens from pure colonies held in the laboratory. Species examined, and their origin were as follows:—

cucumis—Ayr; Lawes; Laboratory colony.

jarvisi—Ayr.

cacuminata—Atherton.

halfordiae—Lawes.

humeralis—Atherton; Laboratory colony.

tryoni—Atherton; Lawes; Rockhampton; Stanthorpe; St. George.

Ovipositors of 50 specimens were examined for each species and each locality. All abdominal segments posterior to the fourth tergite were removed, boiled slowly in 10 per cent. caustic potash for 20 min, and then held in this solution for a further 24 hr. After washing in water, the entire ovipositor together with the fifth tergite were mounted in Womersley's mounting medium on a glass slide. The ovipositor was measured in an extended position; otherwise, if the aculeus remained retracted within the oviscape, the measurement "greatest width of aculeus" could be misinterpreted. Clarity of slides was essential. Also unless slides were prepared carefully, the convexity of the oviscape and fifth tergite presented difficulties when interpreting the limits of the section to be measured. If the mounts were compressed unduly, greater width was recorded.

The measurements taken are shown in Figure 11. To equate variation due to size of specimens, some measurements were expressed as ratios. The following ratios and measurement were examined. The terminology for the segments is that used by Munro (1947).

(a) Length of oviscape(2):apical width of oviscape(3).
(Designated the Oviscape Index (Hardy 1951)).

(b) Length of oviscape(2):length of aculeus(4).

(c) Length of aculeus(4): greatest width of aculeus(5).

(d) Length of oviscape(2):length of fifth tergite (1).

(e) Distance of spiracle (in millimetres) from apex of oviscape(6).

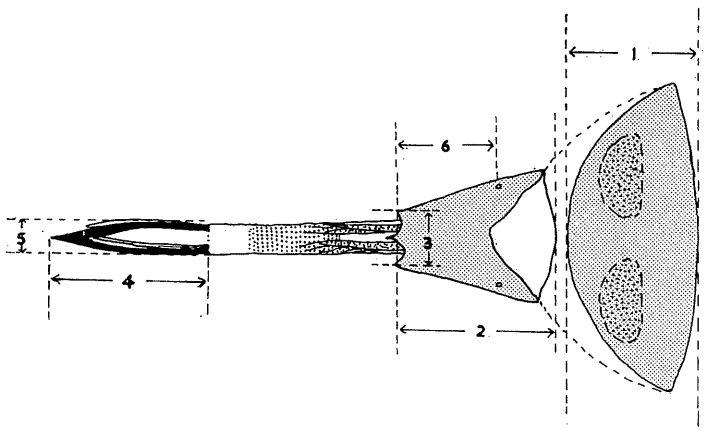


Fig. 11.—Diagrammatic sketch of ovipositor and fifth tergite of *Strumeta tryoni* showing portions measured.

TABLE 6

MEAN RATIOS OF OVIPOSITOR MEASUREMENTS FOR SIX SPECIES OF DACINAE

Species	No. Measured	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
cacuminata ..	50	3·43	1·033	5·31	*	0·888
cucumis	150	3·35	0·814	7·32	1·79	1·079
halfordiae	50	4·17	0·877	7·89	1·95	0·912
humeralis	100	3·27	0·911	6·80	1·43	0·765
jarvisi	50	3·75	0·853	7·55	*	0·947
tryoni	250	3·54	0·914	6·80	1·47	0·764
		3>>1, 2, 4, 6 5>4, 2 6>4	1>>2, 3, 4, 5, 6, 4, 6>>2, 5 4, 6>3 3>>2 5>2	2, 3, 5>>1 4, 6>1	2, 3>>4, 6 3>2	2>>1, 3, 4, 5, 6 1, 3, 5>>4, 6

* Length of the fifth tergite not determined

> = Significantly greater than at 5% level

>> = Significantly greater than at 1% level

Mean ratios for all species are presented in Table 6. Ratios for *cucumis, humeralis* and *tryoni* were calculated from all specimens from all localities. For other species, ratios were calculated from 50 specimens from one locality only. Mean ratios were calculated also for *cucumis, humeralis* and *tryoni* from each of several localities and are presented in Table 7. The lower case letters at the head of columns in Tables 6 and 7 refer to the ratios and measurement listed above.

TABLE 7

MEAN RATIOS OF OVIPOSITOR MEASUREMENTS FOR THREE SPECIES OF DACINAE FROM DIFFERENT LOCALITIES

District	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
1. *cucumis*					
Toowoomba (ex Lawes) Lab.	3·46	0·831	7·85	1·85	1·072
Lawes	3·35	0·811	6·98	1·73	1·106
Ayr	3·23	0·801	7·15	. .	1·060
s.e.	±0·041	±0·0050	±0·102	±0·016	±0·0089
Necessary differences for significance 5%	0·12	0·014	0·28	0·05	0·025
Necessary differences for significance 1%	0·15	0·018	0·34	0·06	0·033
2. *humeralis*					
Toowoomba (Lab.)	3·19	0·906	6·55	. .	0·794
Atherton	3·35	0·916	7·04	. .	0·736
s.e.	±0·030	±0·0057	±0·089	. .	±0·0062
Necessary differences for significance 5%	0·08	0·016	0·25		0·017
Necessary differences for significance 1%	0·11	0·021	0·33	. .	0·023
3. *tryoni*					
Stanthorpe	3·69	0·919	7·10	1·47	0·772
Lawes	3·66	0·909	6·22	1·48	0·762
Rockhampton	3·57	0·917	6·71	1·48	0·764
Atherton	3·41	0·925	6·60	1·50	0·742
St. George	3·36	0·904	7·36	1·42	0·782
s.e.	±0·042	±0·0045	±0·095	±0·013	±0·0068
Necessary differences for significance 5%	0·12	0·013	0·26	0·04	0·019
Necessary differences for significance 1%	0·16	0·017	0·35	0·05	0·025

The data from *cucumis, humeralis* and *tryoni* served to compare frequency distributions of the several criteria examined (Figure 12). In this way, overlap of the distribution curves provided a means of gauging the several ratios and one measurement for separating these three species.

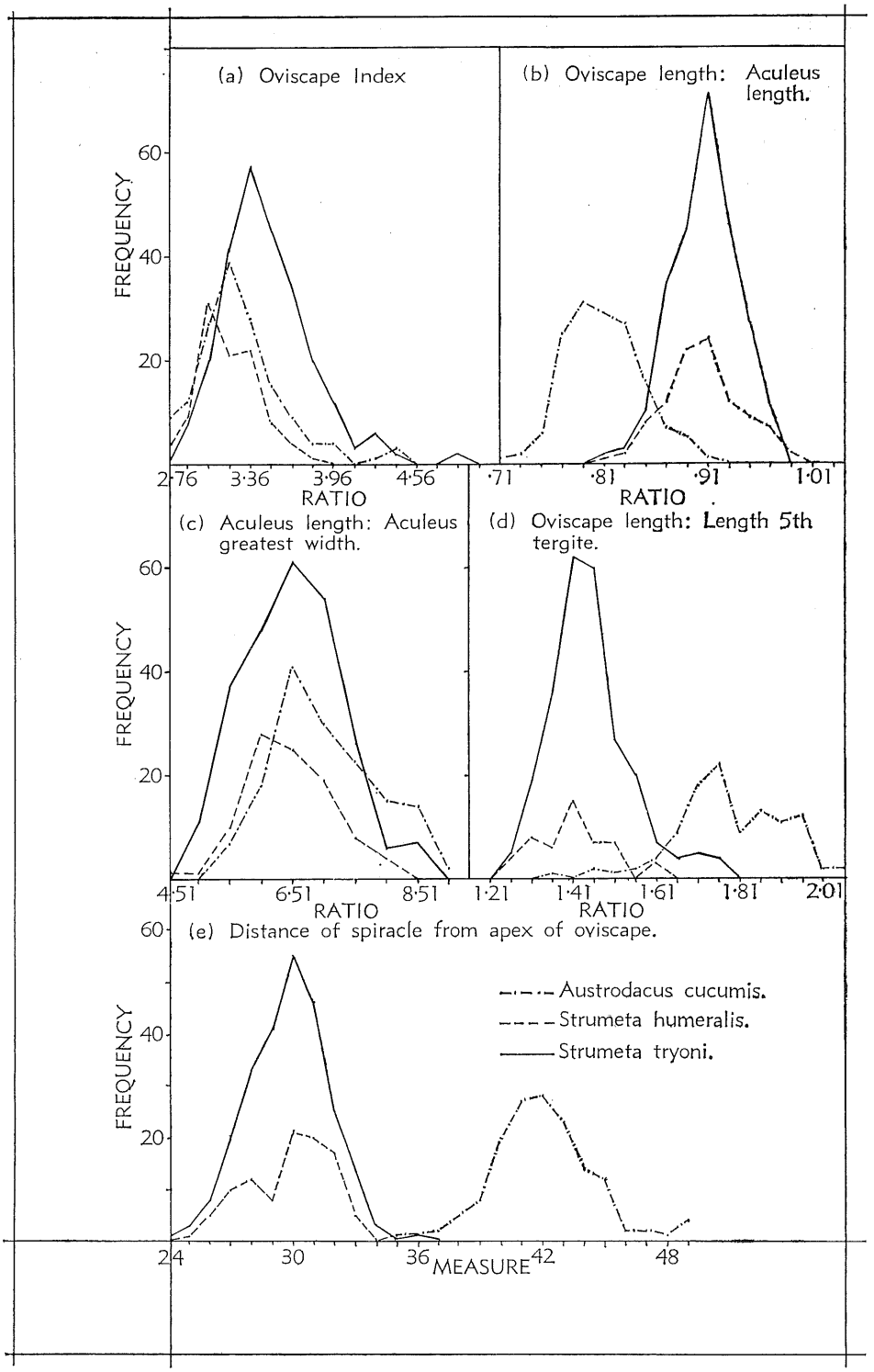


Fig. 12.—Frequency distribution curves for ovipositor characters of *Austrodacus cucumis, Strumeta humeralis and S. tryoni.*

The data exhibited considerable variation within species and between districts for species. Much of this variation arose due to bias and errors when taking measurements. This bias, as a rule, amounted to one scale division on the eyepiece scale, or roughly 0·026 mm, and is what would normally be expected between different operators. This difference was the same as the 1 per cent. necessary difference between districts within species for the only absolute measurement used, e.g. distance of spiracle from apex of oviscape (see Table 7). Error due to different operators could be magnified further when ratios of absolute measurements were calculated.

With the above in mind, it becomes impossible to view each variable in its true perspective and thereby enable a corrected interpretation of the differences encountered between means for districts and to a lesser extent for species.

Despite this, real differences were found between districts for species. This implies a considerable variation within a species which must detract from the significance of any similar differences that are encountered between species. These differences were not large and a considerable overlap in ranges was apparent. Such differences would be of no importance for identifying individual specimens with districts.

Significant and often wide differences were recorded between species (Table 6). In the analyses, district differences within species have been disregarded and the means merely calculated from all data available for each species.

A considerable overlap of ranges for the several ratios was evident between species (Figure 12). This defeats any attempts to differentiate between species by this method. Greatest discrimination between *cucumis* and *tryoni,* two widely dissimilar species, was obtained for the ratios (b) and (d) and the distance of the spiracle from the apex of the oviscape (e). These are concerned with longitudinal measurements and avoid those ratios dependent on width of oviscape and width of aculeus. The latter dimension was open to considerable misinterpretation and errors of measurement. It would seem also that obvious differences in length of the ovipositor between species are not always conveyed when differences are expressed as a ratio based on the dimensions of the respective segments. Linear comparisons are more determinate.

Although overlap of ranges prevents differentiation of species on this basis alone, significant differences between mean values confirm differences between species based on more stable morphological characters. Differences that separate it readily from the other five species are exhibited by *cacuminata* (Table 6). If ovipositors of 50 specimens each of another series of Dacinae were measured, the mean values may fill in the gap and reduce the outlying characteristics of *cacuminata.* Such measures may also invalidate differences found between the other species represented in Table 6. The significance of expected smaller differences when a large number of species are compared may be validated only

by measuring a great many more specimens of each species. This approach has obvious disadvantages. Any attempt to arrive at norms for species based on measurements of a few specimens has distinct limitations.

The results for *humeralis* and *tryoni* reveal a close relationship. Significant differences between means were obtained only for the oviscape index, a doubtful discriminating measure. Other means were very similar for these two species. The frequency distribution curves for the criteria (b), (c), (d) and (e) (Figure 12) are also similar for both species.

Despite significant differences between two species, it is obvious, when range and overlap of values for species as well as possible bias when taking measurements are considered, that species identification should be undertaken, where possible, independently of measurements of this kind. Separation of species based on the different measurements adopted would not be valid, firstly because of the differences between measurements within species, and secondly because the same measure (e.g. oviscape length) may occur in three different ratios and bias or errors of measurement would influence values for all three. To validate differentiation by this method would involve a discriminant analysis. Such an analysis would present a major problem because of the number of species involved.

The use of measurements of the ovipositor for discriminating between species would presuppose a fairly detailed knowledge of the distribution of such measures. It is evident, therefore, that unless differences are most marked, the use of measurements to differentiate between species should be considered only as an additional tool for a detailed systematic study of a group of species. However, to avoid the many pitfalls associated with a study of this kind, the work should be brought to a conclusion by the one operator.

IV. GENERIC CLASSIFICATION

In all previous papers by the author, a system of generic classification of the Dacinae based chiefly on chaetotaxy and male sex characters has been followed. This system was suggested first by Shiraki (1933), and additions were made by Perkins (1937) and Hering (1941). This arrangement of genera presented many anomalies. All characters were given equal status in classification although interspecific variation of one or more of the chaetotaxic characters used was encountered. Also, the use of male sexual characters presented difficulties when only female specimens were available.

Hardy (1951) proposed that species of Dacinae be arranged under four genera separated on distinctive morphological characters and 24 subgenera differentiated chiefly on chaetotaxic and secondary sexual characters. Two of these genera, *Toxotrypana* Gerstaecker and *Monacrostichus* Bezzi, are monotypic and are separated from the others on well-defined morphological characters.

Callantra was considered a valid and well-defined genus, with *Polistomimetes* Enderlein as a possible subgenus. All other groups of species were considered as subgenera of *Dacus* sens. lat. This system in no way overcame difficulties due to variation in chaetotaxy within species, and also created new problems, chiefly phylogenetic, with this arrangement of subgenera.

Australian Dacinae are divisible into two distinct groups of species based on fusion *or non-fusion of the abdominal tergites. Examination of relevant species indicates that this dichotomy is also applicable to species from African and Oriental regions. Most African species have fused tergites, while for the majority of the species from the Oriental and Pacific regions the tergites are free. The few species with non-fused tergites in the African region exhibit a closer affinity both morphologically and biologically with Oriental and Pacific species. Munro (1933) had drawn attention to the occurrence in Africa of these occasional species and stated that ". . . apart from the points noted [chaetotaxic characters], the three species [*mesomelas* Bezzi, *biguttulus* Bezzi and *oleae* Gmelin] agree in a character that may prove of more importance than the differences in chaetotaxy: namely, that the abdominal segments are not fused, as is the case in most of the African Dacinae, but are free." Several species with fused tergites occurring in Oriental and Pacific areas are related closely to the general concept of African species and exhibit biological affinity in that most are bred from either *Cucurbitaceae* or *Asclepiadaceae*.

The grouping of species based on fusion or non-fusion of the abdominal tergites has been followed in this paper. The shape of the abdomen and abdominal tergites, as well as the degree of development of the antero-lateral humps on the first abdominal tergite, also serve to separate genera. These characters have been used to separate *Callantra* and *Polistomimetes* from other genera (Hardy and Adachi 1954) but are often ill-defined by authors and in consequence much confusion has been created. The degree of development of these abdominal characters is closely related to fusion or non-fusion of the tergites.

Generic concepts based on fusion or non-fusion of tergites presupposes a revision of species groupings within the Dacinae. This would involve a broad division of genera, each group in turn subdivided into subgroups of genera (or subgenera) based on chaetotaxic, sexual, antennal and certain abdominal characters.

From a limited study of species from African, Oriental and Pacific regions, the following arrangement of genera is suggested. A more detailed search of characters among the world Dacinae would be required before this arrangement could be established. This was beyond the scope of this work.

* This character is appreciated readily following dissection after soaking the abdomen for a time in a 10 per cent. solution of caustic potash.

Group A—Tergites fused:

(1) *Toxotrypana.*

(2) *Monacrostichus.*

(3) *Callantra, Paracallantra, Polistomimetes, Tetradacus.*

(4) *Dacus* (= *Neodacus*), *Didacus.*

(5) *Leptoxyda, Lophodacus, Metidacus, Psilodacus.*

Group B—Tergites free:

(1) *Afrodacus, Asiadacus, Daculus* (= *Heterodaculus*), *Notodacus, Strumeta* (= *Apodacus*).

(2) *Gymnodacus, Nesodacus.*

(3) *Diplodacus, Neozeugodacus, Paradacus, Zeugodacus* (= *Parazeugodacus*).

(4) *Austrodacus, Paratridacus* (= *Melanodacus*).

The synonyms included in the above groupings have been discussed on page 17.

V. SPECIATION

Four species of Queensland Dacinae—*exiguus, flavinotus, furvus* and *tigrinus*—do not fit adequately into any known genus. The grouping of these species is discussed below.

The generic positions of *absonifacies, calophylli, newmani, signatifrons, strigifinis* and *visendus* have been changed following a better appreciation of the generic character, fusion or non-fusion of the abdominal tergites, and of the value of the supernumerary lobe for generic classification. The reasons for the regrouping of these species are discussed below.

The majority of the 54* Queensland species of Dacinae have been described adequately for species determination. Some earlier descriptions, however, are too sketchy for the separation of closely allied species. These have been revised and the additional characters are presented below or are given in Appendix 1. Many abberant forms or colour forms were recognized within species. These are discussed under the respective species.

AFRODACUS Bezzi

Species within this genus differ from *Strumeta* merely in having no *a.sa.* bristle. Though the presence or absence of this bristle usually is consistent within species, exceptions have been noted, especially among series of specimens of

* The New Guinea species (*Paratridacus atrisetosus* (Perk.) was mistakenly recorded from Queensland (Perkins and May 1949), the name being given, in error, to teneral specimens of a species later described by Hardy (1951) (viz. *Neozeugodacus aglaiae* (Hardy))

A. jarvisi (see Hardy 1951, p. 117) and *S. mutabilis* (see May 1951, p. 5). These inconsistencies and an apparent lack of related characters to support the chaetotaxic difference would suggest that Afrodacus is best treated as a subgenus of *Strumeta*.

Three Queensland species—*flavinotus, furvus* and *tigrinus*—have been placed in *Afrodacus* (May 1952, 1957*b*) because these lack the *a.sa* bristle. The males of only two of these three species have been taken. These possess a pronounced bulla on the cubital vein. With the exception of *S. mcgregori* (Bezzi) from the Philippines, these are distinct from all other Dacinae. All four species possess unusually short and thick antennae (see Appendix 1), and an almost straight (in profile) unmarked face without well-defined antennal grooves. The three Queensland species are found to possess also three well-developed bristles beneath the apical half of the fore femora and a strongly developed supernumerary lobe in the wing of the male.

This combination of characters suggests a new genus (or subgenus) distinct from *Afrodacus* for *flavinotus, furvus* and *tigrinus*. Larger series of specimens of each species are necessary to establish this genus.

ASIADACUS Perkins

Perkins erected *Asiadacus* to contain *bakeri* Bezzi and *diversus* Coquillet, and designated the former as type species. Bezzi (1919) stated that *bakeri* has a pecten of cilia on the abdomen, although he misplaced the species in his key, and that "it seems that the anterior *s.a.* bristles as well as the *pr.sc.* are present." Perkins repeated Bezzi's errors when defining *Asiadacus,* for he considered *bakeri* lacked a pecten of cilia on the abdomen and possessed both *a.sa.* and *prsc.* bristles.

Hardy (1954) stated that the type of *bakeri* was located subsequently in the collection of the U.S. National Museum, Washington. From the information available to him he decided that the species "apparently fits" in the genus *Neodacus* Perkins. He therefore treated *Asiadacus* as a synonym of *Neodacus*. Information provided by Dr. R. H. Foote, U.S. Department of Agriculture, Washington (personal communication) reveals that the type of *bakeri* lacks *prsc.* bristles, though the *a.sa* bristles are present. This association of characters confirms Hardy's conclusion.

The type species of *Neodacus, newmani,* has fused tergites. The tergites of *bakeri* are not fused. In this paper *Neodacus* is treated as a synonym of *Dacus* sens. strict. because of the congeneric type species. (The character, presence or absence of the supernumerary lobe, shows considerable intergradation within a group of species and is not considered a sound generic (or subgeneric) character —see p. 17).

Thus *Asiadacus* can be considered a valid genus. A corrected description of characters of *bakeri* would define the genus as follows:—Dacinae with 2 *sc.*, 1 *a.sa.* and no *prsc.* bristles; tergites not fused; antennae not longer than face; abdomen not petiolate or clavate; and a pecten of cilia on the third abdominal tergite.

Those species of Dacinae with free tergites, grouped by Hardy (1954) under *Neodacus,* should be grouped under *Asiadacus* as these possess characters found also in *bakeri.* The species *strigifinis,* previously placed under *Neodacus,* is an *Asiadacus.*

AUSTRODACUS Perkins

Austrodacus cucumis

Tryon (1927) and Hardy (1951) redescribed this species. Several characters of importance for identification were overlooked or inadequately described. These are given below for both the usual and the melanic forms of the species.

The usual form comprises the bulk of field populations. Invariably, the female is considerably larger than the male.

Thorax.—Mesonotum pale red-brown, except darker between humeral and notopleural calli and at inner posterior end of each lateral post-sutural stripe. Pleura fulvous, mesopleural stripe curved on anterior margin and reaching to anterior notopleural bristle above but narrowing before crossing sternopleural suture to end in a large, very broad white spot. Lateral post-sutural stripe broad, almost parallel-sided, commencing just before suture and ending at upper *p.sa* bristle. Medial vitta on mesonotum commencing almost level with suture and broadening to end level with lateral post-sutural stripes; rounded at both extremities. *Wing*: costal cells very pale fulvous.

Abdomen.—An elongate black spot medially on fifth tergite which may be continued anteriorly as a thin, faint, fuscous line on the third and fourth tergites.

The melanic forms are not uncommon among a large series of field specimens and differ from the usual form in both size and colour as follows:—

Length of body (female): usual form 7·1 mm.

melanic forms 4·7 mm–6·0 mm.

Thorax.—As for usual form except fuscous:—between humeral and notopleural calli; along inner margins of lateral post-sutural stripes and on either side of medial vitta; behind notopleural callus; before and behind mesopleural stripe; on lateral margins of postnotum.

Abdomen.—As for usual form except fuscous:—on anterior half of first and second tergites; broadly on lateral margins of third, fourth and fifth tergites. Also, a black indefinite medial line on third and fourth tergites, expanding into a broad elongate black spot on fifth tergite.

CALLANTRA Walker

Characters of the antennae have been used to separate *Callantra* from other genera (Hardy 1955). This method, though reliable for most species, is quite unsatisfactory for *C. aequalis* (see Appendix 1). Abdominal characters are a more reliable means of differentiation, especially the shape of the first segment. The characters of the abdomen of *Callantra* are discussed on page 18.

Callantra aequalis

This species has been redescribed by Tryon (1927) and Perkins (1934). Characters not included in these or the original description are given below and in Appendix 1:—

Head.—Frons flattened with no anterior hump. Facial spot elongate, reaching hypostome. Post-vertical bristles present though weak. Gular bristle weak, pale. Longitudinal reddish band on face.

Thorax.—Scutellum yellow except basal third brown. Humeri brown. Mesopleural stripe replaced by yellow band of width equal to notopleural callus and running from sternopleural suture to include notopleural callus and continuing along front of thoracic suture to end at its inner extremity. Upper hypopleural callus chiefly red-brown; lower with central half whitish. *Wings:* generally very pale brown. Dense microtrichia in both costal cells. Costal band confluent with m_{1+2} for its entire length but paler at the base of cell R. *Legs*: a row of five spines on upper surfaces of fore femora.

Abdomen.—Tergites fused. Not strongly petiolate; strongly arched in side view; segment 5 square on hind margin; generally club-shaped; first segment parallel-sided (or nearly so), almost twice as wide (57 div.) as long (33 div.) and antero-lateral humps very prominent (Figure 6). Suture between tergites 3 and 4 not as strongly concave forwards as in other Queensland *Callantra* species. Widest point of abdomen level with posterior margin of fourth tergite. Hind margin of second tergite whitish and strongly convex forwards. Oviscape, red-brown, cylindrical, almost twice as long as fifth tergite.

C. aequalis, like *C. lounsburyi* (Coquillet) from South Africa, is not a typical *Callantra* but shows an affinity with some species of *Dacus* sens. strict. or *Didacus*. Although the antennae of *aequalis* are much shorter than for other species of *Callantra* (see Appendix 1), the wing and abdominal characters conform to the general pattern for the genus.

DACULUS Speiser

= *Heterodaculus* Hardy 1951. *Pacif. Sci.* 5 (2): p. 134.

Hardy (1951) erected *Heterodaculus* to contain *visendus*. This genus was differentiated from *Daculus* merely by the absence of a supernumerary lobe in the male wing, a character having no generic value. In this paper, *Heterodaculus* is considered a synonym of *Daculus*.

Daculus exiguus

This species was placed provisionally under *Psilodacus* Collart (May 1957*b*), but as the tergites of *exiguus* are not fused, this association was incorrect. It is obvious that the characters of the species do not fit any known genus (or subgenus), and until more specimens can be taken, *exiguus* is best placed under *Daculus*. Species in this genus have free tergites but differ from *exiguus* by possessing a pecten of cilia on the abdomen of the male.

Daculus murrayi

This species was described by Perkins (1939) and redescribed by Hardy (1951). Hardy noted variation within a series of specimens from Queensland, some having either one or two *prsc.* bristles. Abnormal specimens were encountered also during these studies. In a series of 30 specimens bred from the host *Semecarpus australiensis* Engl., three had two and two had one *prsc.* bristle present. Four specimens among 20 field specimens taken from traps had prescutellar bristles. However, the *a.sa.* bristle was absent in all 50 specimens examined.

DACUS Fabricius

= *Neodacus* Perkins 1937. *Proc. Roy. Soc. Qd* 48 (9): p. 58

Perkins (1937) erected the genus *Neodacus* for *newmani*. The species *signatifrons* is very close to *newmani* (May 1955). Both species have fused abdominal tergites. Perkins (1937) noted the dissimilarity between *newmani* and species of Dacinae from eastern Australia and considered it looked "more like an African than an Australian species . . .". The species *newmani* and *signatifrons,* in general, differ from species of *Dacus* sens. strict. merely in possessing a weakly developed supernumerary lobe. This character has no generic value and *Neodacus* is treated as a synonym of *Dacus*.

The correct generic position of *absonifacies* was in some doubt (May 1955) and the species was grouped provisionally under *Polistomimetes*. The characters of this genus, namely the shape of the abdomen and antennae, are now known to bear a close relationship with those of typical *Callantra*. The characters of *absonifacies* do not show this relationship. A more recent appreciation of this species revealed the presence of fused tergites and general characteristics that place it in *Dacus* sens. strict.

D. absonifacies possesses abdominal and colour characters that suggest a linkage with *C. aequalis*. The length of the first abdominal segment in proportion to its width is 0·5:1 in *absonifacies* and 0·6:1 in *aequalis*. For *auricoma* and *petioliforma,* both typical *Callantra* species, these ratios are 1·5:1 and 2·8:1 respectively. The general shape of the abdomen of *aequalis* is club-shaped and not oval as in *absonifacies,* although for both species the second tergite is convex

forwards along its posterior margin. For typical *Callantra* this tergite is straight or concave forwards along its posterior margin. Both *absonifacies* and *aequalis* suggest a linkage between *Callantra* and *Dacus*. Both were bred, also, from the same host (May 1957*a*).

DIPLODACUS May

Diplodacus signatifer

Considerable variation has been observed in the number and size of scutellar bristles for this species (Hardy 1951, 1955; May 1953). The number may vary from four to two. When the sub-apical pair are weak these are pale coloured although the alveoli are always present.

Following an examination of a series of 95 specimens, 18 had two pairs of strong bristles, 38 had the sub-apical pair weak, 29 had the sub-apical pair very weak, and 10 had only the apical pair evident.

Hardy (1955) placed *signatifer* under *Daculus*. *Diplodacus* is more closely linked to *Zeugodacus* than *Daculus*.

GYMNODACUS Munro

Gymnodacus calophylli

Perkins (1937) had separated [*Gymnodacus*] *mesomelas* from the characters listed for his genus *Asiadacus* merely on the degree of development of the supernumerary lobe. Among specimens of *calophylli* this lobe may be weakly developed or absent and has no generic significance.

Perkins and May (1949) described *calophylli* under *Asiadacus*. This genus was incorrectly established by Perkins, and the revised characters based on a re-examination of the type species are presented elsewhere in this paper (see p. 39). As *calophylli* possesses characters found in *Dacus mesomelas* the type species of *Gymnodacus,* it is correctly assigned to *Gymodacus*.

Characters of the abdomen of *calophylli* given in the description by Perkins and May (1949) were incorrect. These have been described correctly by Hardy (1951).

PARATRIDACUS Shiraki

Melanodacus was erected by Perkins to contain *niger,* a small black species very unlike most other species of Dacinae. Another small black species, *satanellus* Hering, very similar to *niger* in general appearance, was described later from New Guinea.

Melanodacus has been separated from *Paratridacus* merely on the degree of development of the supernumerary lobe in the male wing. Until other characters can be found which enable a more effective separation of these two dissimilar groups of species, *Melanodacus* should be considered a synonym of *Paratridacus*.

STRUMETA Walker

This genus with free tergites has been well defined by Perkins (1937). It contains the majority of the Dacinae recorded from Queensland. Several species of Queensland *Strumeta* have not been adequately described. Characters not included in original descriptions or requiring further enumeration are given below or are included in Appendix 1.

On occasions, specimens were taken that did not conform to the characters of the type for that species. These differed chiefly in colour and did not warrant subspecies rank. These aberrant forms are also discussed below.

Strumeta bancroftii

Typical specimens conform in general detail to Tryon's (1927) description except for the colouration of the thorax and the facial spots. Tryon's description agrees with the colouration of teneral specimens.

Characters not covered adequately by Tryon are as follows:—

Head.—Face fulvous; spot large, circular, pointed anteriorly, in lower half of antennal groove. Genal bristle pale brown.

Thorax.—Mesonotum mostly black and covered with short, pale hairs except on paired shining black lines which extend from inner edge of humeri to touch inner end of suture and terminate at a point level with posterior end of lateral post-sutural stripes and hoary between these bands; red-brown bordering humeral calli and continuing backwards along margins of mesonotum to end at inner end of suture, also beneath and behind lateral post-sutural stripes. Pleura yellow-brown except fuscous bordering anterior margin of mesopleural stripe, on sternopleuron and above hind coxae. Lateral post-sutural stripe broad, parallel-sided, rounded posteriorly and ending at upper *p.sa.* bristle. Mesopleural stripe narrow, almost parallel-sided, slightly broader than notopleural callus.

Variants from the normal form were encountered. These were always smaller and exhibited a thin medial fuscous band on the third, fourth and fifth tergites. Also, the anterior third of the second tergite was darker, tending fuscous, while the first tergite was often entirely fuscous. In normal specimens, the abdomen is uniformly orange-yellow.

Strumeta bilineata

Colour forms of this species were taken. The type and paratypes exhibit paired black bands on the mesonotum (Perkins and May 1949). A proportion of field specimens taken from traps or specimens bred from the wild host *Planchonella pohlmanianum* (F. Muell.) Pierre ex Dubard in southern Queensland were devoid of black on the mesonotum. These were much larger than specimens marked with black on the dorsum.

This species can be distinguished also by the moderately broad lateral post-sutural stripe which narrows to a point posteriorly and ends just short of the upper *p.sa.* bristle; and the markings of the abdomen.

Strumeta breviaculeus

Hardy (1951) described *breviaculeus* from teneral specimens. Field specimens are much darker on the mesonotum and some may tend towards dark reddish-brown or even fuscous. Specimens taken at Byfield, at the southern end of the known range for this species, were almost entirely fuscous on the mesonotum and pleura and over the greater part of the third, fourth and fifth tergites. The central portions of tergites 4 and 5 were rich brown in colour.

Typical specimens of *breviaculeus* are reddish-brown on the mesonotum except for paired broad hoary bands extending for the entire length of the mesonotum (and coinciding with the areas of attachment of the longitudinal flight muscles), and separated longitudinally by a thin, shiny, fuscous line and bounded laterally by pronounced shiny, fuscous to black, broad, slightly bow-shaped lines which thicken at each extremity.

The costal cells of aged field specimens are usually pale fulvous but may tend towards brown.

Strumeta cacuminata

Considerable variation in size and colour is evident among specimens of this species (May 1953). This variation was measured within a series of 302 specimens bred from fruits of the wild host *Solanum auriculatum* Ait. collected on September 21, 1950, at Dagun, near Gympie, Qld. Six colour forms were recognized, ranging from specimens almost devoid of black markings on the mesonotum (Figure 9, Stage A) to specimens almost wholly black on the mesonotum and first two abdominal tergites (Figure 9, Stage F). The number and mean size of specimens within each colour form were recorded. Size was determined by measuring the length of the mesonotum (in millimetres). The results obtained are set out in Table 8:

TABLE 8

NUMBER AND MEAN SIZE OF EACH COLOUR FORM WITHIN A SERIES OF *S. cacuminata*

Colour Form	Number	Mean Length (mm)
A	11	2·13
B	107	2·08
C	85	1·95
D	65	1·78
E	27	1·65
F	7	1·63

As with *tryoni* (see Table 2), size of specimen decreased as melanin formation increased.

S. cacuminata shows some affinity with the *dorsalis-ferrugineus-pedestris* complex of species which occur in regions of south-eastern Asia. Males of all species in this complex are attracted to methyl-eugenol. Specimens labelled "*D. ferrugineus,* ex mango and solanum, 28.v.07, Calcutta, India" in the collection of the U.S. National Museum, Washington, were examined. These exhibited colour patterns on the mesonotum and general characteristics very similar to those of *cacuminata* and could be classed as this species.

A wide range of colour forms has for some time confused the taxonomy of the *dorsalis-ferrugineus* complex. A resemblance between *cacuminata* from Queensland and specimens labelled *ferrugineus* from the Indian region would warrant a more detailed comparison between these and allied species.

Strumeta fagraea

Though this species was described in detail by Tryon (1927) and Hardy (1951), some important characters were not featured. These are given below:—

Thorax.—Mesopleural stripe slightly wider than notopleural callus and almost parallel-sided (not as in *S. tryoni*—see Tryon 1927, p. 189). Scutellum yellow, except basal third of disc red-brown (Tryon stated that the scutellum was wholly yellow). *Wing*: costal cells fulvous in indurated field specimens and wing membrane with a brownish tinge.

Abdomen.—Field specimens often possess a faint fuscous medial band on tergites 3 and 4 which darkens to become more conspicuous on the fifth tergite.

Strumeta halfordiae

The species has been described by Tryon (1927), Perkins (1934) and Hardy (1951), although these authors did not recognize the many colour forms encountered among specimens bred from the same host collection. As with other species (see Figure 9), a progressive increase in melanin on the thorax and abdomen coincides with a general decrease in body length.

None of the three descriptions cited above are of the normal form, which is best described as follows:—

Head.—As in Perkins' (1934) description.

Thorax.—Generally devoid of fuscous markings on the mesonotum. Brown to yellow-brown except for a pair of shiny, brown, narrow bands extending from inner anterior edge of each humeral callus to posterior margin of mesonotum, thickened slightly at each extremity and interrupted for a short distance near the suture. A narrow, darker brown line bordering the inner edge of each lateral post-sutural stripe. Calli and markings on pleura as in Perkins' (1934) description.

Abdomen.—Brown except first and second tergites paler (yellow-brown) except posterior portion of second tergite whitish. Paired black spots on fifth tergite.

The extreme melanic form differs in colour from the normal form as follows:—

Thorax.—Mesonotum yellow-brown except for a pair of bow-shaped fuscous bands running from inner anterior edge of humeri to the hind border; a fuscous area between humeral and notopleural calli; a fuscous band adjacent to the inner posterior margin of the lateral post-sutural stripe; a pair of thin fuscous lines, centrally placed on the anterior portion of the mesonotum, extending backwards, and at the same time widening to end in an indefinite fuscous area immediately anterior to the *prsc.* bristles. Pleura almost entirely fuscous except for yellow-brown beneath humeral calli. Postnotum black.

Abdomen.—Anterior half of first tergite fuscous; second tergite with medial fuscous spot and fuscous blotches laterally; third and fourth tergites fuscous except fulvous in posterior medial half of fourth; and fulvous over all of fifth tergite except for paired black spots.

All gradations between this and the normal form were encountered.

Note: An extreme melanic form reared from an apple infested by *S. halfordiae* in the laboratory was intensely fuscous on the mesonotum, while faint infuscation was evident on the *r-m* and *1m* cross veins of the wing.

Strumeta humeralis

Occasional specimens were captured in live traps which did not conform to the usual form described by Perkins (1934). These were largely red-brown on the thorax with fuscous areas only on the anterior third of the mesonotum and on the sternopleuron. Typical specimens of *humeralis* are more intensely fuscous on the thorax (see Figure 2).

All specimens of *humeralis* examined during these studies possessed a dark brown or black humeral callus.

Strumeta kraussi

Field specimens of *kraussi* are much darker than the specimens on which Hardy's (1951) description was based. In general, the markings resemble those described above for melanic forms of *halfordiae* and in many respects these species show similarity.

The host ranges for *halfordiae* and *kraussi* are very similar, both species having been bred from fruits of *Annonaceae, Myrtaceae, Rutaceae* and *Thymeleaceae*. The latter species has been bred from *Acronychia* sp. aff. *laevis* Forst. collected on the Atherton Tableland, North Queensland. This host is

not readily separated botanically from *A. laevis* Forst., an important host of *halfordiae,* which is widespread in coastal southern Queensland. The species has been bred also from *Halfordia scleroxyla* F. Muell., which may prove to be no more than varietally distinct from *H. kendack* (Montr.) Guillaum, the type host of *halfordiae.* Other records confirm a close relationship between the host ranges of those two species.

These species are separated merely on colour characters. Both exhibit well-developed and long ovipositors in the females, pronounced paired spots on the fifth tergites, similarly coloured (fumose) wings, similarly shaped facial spots and near parallel-sided, narrow mesopleural stripes. The colour of the thorax of *kraussi* is basically reddish-brown (cf. *halfordiae,* brown to yellow-brown) with fuscous markings as follows:—paired bow-shaped lines extending from humeri to posterior margin of mesonotum and noticeably thickened at each extremity; over area between humeral and notopleural calli; along inner edge of lateral post-sutural stripes; before and behind mesopleural stripe; and on anterior portion of sternopleuron.

The basal portion (as much as one-third) of the scutellum is brown as in *halfordiae.* This character was not mentioned by Hardy (1951), but is somewhat variable in other than indurated specimens.

The facial spot is usually elongate oval but may vary and be represented in some specimens merely by a thin black line. The spot is, however, always pointed anteriorly and is usually more or less top-shaped as in *fagraea* and *halfordiae.*

Strumeta pallidus

This is an extremely variable species and many colour forms were encountered. Specimens received for identification from the Kimberley and Ord River districts, W.A., were generally much darker than typical Queensland specimens.

Melanic forms were encountered in Queensland among trapped material and specimens bred from the wild host. These were rich red-brown on the mesonotum, as for typical specimens, but in addition exhibited fuscous markings as follows:—between humeral callus and suture; bordering inner edge of lateral post-sutural stripes; and as a pair of thin black bow-shaped bands extending backwards from the anterior margin to end at a point roughly two-thirds the distance to the posterior margin and sometimes interrupted for a short distance near the suture. Fuscous also both anterior and posterior to mesopleural stripe; on sternopleuron; and above hind coxae.

Note: This pattern of fuscous markings is basic to all melanic forms of species normally pale-coloured on the thorax (cf. melanic forms of *halfordiae* and *tryoni* (see Figure 9)).

Strumeta silvicola

The paler, larger form of this species (see May 1962*a*) is very similar in general appearance to those specimens of *S. bilineata* devoid of black markings on the mesonotum. Most specimens of *silvicola* taken at Byfield, the southernmost locality recorded, and some taken at Rita Island, near Ayr, were exceptionally dark in colour. The thorax was black except for the faintest suggestion of reddish-brown on the posterior medial portion of the mesonotum, at the inner end of the suture and beneath each lateral post-sutural stripe. The abdomen was black except for:—a thin fulvous band on the anterior margin and a whitish area on the posterior third of the second tergite; and a rufous area intersected by the broad medial black band on the central portion of the fifth tergite. These, however, were not as small as the melanic forms described from Atherton (May 1962*a*), and a very dark specimen from Byfield measured 6·1 mm in length.

Strumeta tryoni

Considerable colour variation has been recorded among specimens of this species (May 1953). This variation has been described (see p. 22) and figured (Figure 9) elsewhere in this paper.

The species has never been described adequately. Descriptions by Froggatt (1897), Tryon (1927) and Hardy (1951) were at variance, as both teneral material and colour forms of the species were the basis for these descriptions. Sclerotized field specimens are very much darker in colour.

The main characters of typical *tryoni* are as follows:—

Head.—In general, rich fulvous except occiput darker centrally and face rich yellow.

Thorax.—Rich red-brown with central area of mesonotum tomentose and appearing greyish. Area between humeri and suture darker brown tending fuscous, and with similarly coloured blotches posterior to lateral post-sutural stripes and on posterior portion of mesonotum. Postnotum piceous laterally and centrally red-brown. Lateral post-sutural stripe not broad, triangular and ending well before upper *p. sa.* bristle (level with lower *p. sa.* bristle). Mesopleural stripe broad but not attaining anterior notopleural bristle on the upper margin and narrowing below to equal the width of notopleural callus and extending as a small spot onto sternopleuron. Pleuron rich red-brown except black over greater portion of sternopleuron, a black spot above hind coxae and beneath wing. Blotched with black along anterior and posterior margins of mesopleural stripe.

Abdomen.—First tergite dark brown to black. Second tergite fulvous except posterior half whitish. Third, fourth and fifth tergites basically reddish-brown but overlain except on the central portions of each of these tergites with fuscous blotches which impart a generally darker colour. A faintly visible thin, fuscous, medial band on the last three tergites. Paired dull yellowish-brown spots on fifth tergite. Ovipositor fulvous; visible portion of oviscape shorter than fifth segment.

VI. SPECIES OF DACINAE OCCURRING IN QUEENSLAND

The following lists sets out the new or recent synonymy. All species are treated at generic level, although deficiencies are admitted in this system of classification for the Dacinae*.

Afrodacus

brunneus Perkins and May 1949
? *flavinotus* May 1957
? *furvus* May 1957
jarvisi (Tryon) 1927
mesoniger May 1951
? *tigrinus* May 1952

Asiadacus

s. strigifinis (Walker) 1861
{ = *Neodacus lanceolatus* Perkins 1939
{ *Neodacus strigifinis* (Walker) (see May 1962*a*)

Austrodacus

cucumis (French) 1907

Callantra

aequalis (Coquillet) 1909
auricoma May 1955
petioliforma May 1955

Daculus

? *exiguus* (May) 1957
(= *Psilodacus exiguus* May)
murrayi Perkins 1939
visendus (Hardy) 1951
(= *Heterodaculus visendus* Hardy)

Dacus

absonifacies (May) 1955
(= *Polistomimetes absonifacies* May)
newmani (Perkins) 1937
(= *Neodacus newmani* Perkins)
signatifrons (May) 1955
(= *Neodacus signatifrons* May)

Diplodacus

signatifer (Tryon) 1927

Gymnodacus

calophylli (Perkins and May) 1949
(= *Asiadacus calophylli* Perkins and May)

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* See p. 35

Neozeugodacus

aglaiae (Hardy) 1951
aureus May 1951

Paratridacus

expandens (Walker) 1859
niger (Tryon) 1927
(= *Melanodacus niger* (Tryon))

Strumeta

alyxiae May 1952
amplexiseta May 1962
bancroftii (Tryon) 1927
barringtoniae (Tryon) 1927
bidentata May 1962
bilineata Perkins and May 1949
breviaculeus Hardy 1951
bryoniae (Tryon) 1927
cacuminata Hering 1941
endiandrae Perkins and May 1949
fagraea (Tryon) 1927
fuscatus Perkins and May 1949
halfordiae (Tryon) 1927
hispidula May 1957
humeralis (Perkins) 1934
kraussi Hardy 1951
melas Perkins and May 1949
mendosa May 1957
musae (Tryon) 1927
mutabilis May 1951
notatagena May 1952
pallidus Perkins and May 1949
phaleriae May 1955
pulcher (Tryon) 1927
quadrata May 1962
recurrens Hering 1941
robiginosa May 1957
silvicola May 1962
strigatus (Perkins) 1934
tryoni (Froggatt) 1897

Zeugodacus

choristus May 1962
(nec. *Zeugodacus synnephes* (Hendel) 1913)

VII. KEY TO THE SPECIES OF DACINAE OCCURRING IN QUEENSLAND

The following key permits species determination without recourse to generic classification. This overcomes complete reliance on chaetotaxic and secondary sexual characters. Identification is possible also should either sex be considered.

Characters showing little variation have been preferred. Where a character may exhibit variation for a species, either possibility is catered for. Colour characters that may vary have been avoided. Measurements or ratios of measurements also have been avoided for obvious reasons. The colour of costal cells has been used to differentiate between species only when little or no variation from the norm can be expected.

Bristles frequently are lost from dried or spirit material. Finality in this character can be decided only by ascertaining whether or not the alveolus is present.

The existence of brown or black markings on the scutellum of teneral or spirit material may be difficult to establish. This is particularly the case with inferior specimens of *A. mesoniger, S. bancroftii,* and *S. halfordiae* and has been allowed for in the key.

1. Costal band present 2
   Costal band lacking ..... *Paratridacus niger* (some specimens)

2. Costal band broken in middle, there being an isolated apical spot 3
   Costal band entire 4

3. Notopleural callus brown; *r-m* cross vein infuscated ..... *Afrodacus furvus* (males)
   Notopleural callus yellow; *r-m* cross vein not infuscated ..... *Afrodacus tigrinus* (males)

4. Costal band extended for its entire length well below vein r_{4+5} 5
   Costal band confluent with r_{4+5} for its entire length, not or barely over this vein except at or beyond *r-m* cross vein 8
   Costal band narrow, not attaining r_{4+5} distal to *r-m* cross vein except on wing margin after crossing r_{2+3} at its tip 14

5. Costal band confluent with vein m_{1+2} for its entire length, not or barely crossing this vein 6
   Costal band not attaining vein m_{1+2} for its entire length 7

6. Abdomen slightly petiolate and strongly clavate; *a.sa.* bristle wanting; third antennal segment more than 1½ times length of face ..... *Callantra aequalis*
   Abdomen oval, not petiolate or clavate; *a.sa.* bristle present; third antennal segment about equal length of face ..... *Dacus absonifacies*

7. Row of spines beneath fore femora; black spot on eye margin level with base of antenna; facial spot elongate; oviscape short ..... *Callantra petioliforma*
   No spines beneath fore femora; frons and face chiefly fulvous; facial spot pear-shaped or oval; oviscape elongate ..... *Callantra auricoma*

8. Infuscation on wing in addition to costal band and anal streak 9
No infuscation on wing other than costal band and anal streak 12

9. Mesopleural stripe broad, attaining humeral callus; infuscation on wing either S-shaped or in two separate bands 10
Mesopleural stripe not attaining humeral callus; infuscation on wing either as a broad central band or as an apical blotch 11

10. Costal cells colourless; microtrichia in outer portion of second costal cell only; no medial black vitta on abdomen ..... *Strumeta alyxiae*
Costal cells coloured; microtrichia over greater part of second costal cell and upper portion of first cell; a medial black vitta on abdomen ..... *Strumeta recurrens*

11. Mesopleural stripe broad, 1½ times as wide as notopleural callus; apical third of wing fuscous; lateral post-sutural stripe broad, parallel-sided, ending behind upper *p.sa.* bristle ..... *Strumeta amplexiseta*
Mesopleural stripe narrow, about as wide as notopleural callus; infuscation over central portion of wing only; lateral post-sutural stripe narrow and ending before upper *p.sa.* bristle ..... *Strumeta pulcher*

12. Mesonotum black; microtrichia in outer portion of second costal cell only ..... *Strumeta bryoniae*
Mesonotum wholly red-brown or with a pattern of black markings; microtrichia over most of second costal cell and at least outer half of first cell 13

13. A small species; mesonotum red-brown with a medial, longitudinal, black band; last three tergites largely fuscous ..... *Strumeta notatagena*
A large species; mesonotum chiefly red-brown; last three tergites red-brown except darker laterally and a thin darker medial band ..... *Paratridacus expandens*

14. Four scutellar bristles 15
Two scutellar bristles 21

15. Medial yellow vitta on mesonotum 16
No medial yellow vitta on mesonotum 19

16. Outer median cross vein infuscated; costal band ending in apical spot; dark band along anterior border of third tergite ..... *Zeugodacus choristus*
No infuscation on outer median cross vein; no apical thickening of costal band; abdomen pale or lacking a transverse dark band on anterior half of third tergite 17

17. Prescutellar bristles present; a medial vitta extending almost full length of abdomen ..... *Neozeugodacus aglaiae*
Prescutellar bristles absent; a medial, elongate black mark, at most, on fourth and fifth tergites 18

18. Medial vitta on mesonotum long and narrow with apex commencing level with posterior borders of humeri; facial spots large, tending oval; oval black spot on fifth tergite; pecten on male abdomen; strong supernumerary lobe and dense microtrichia at extremity of vein $cu_1 + 1a$, in male ..... *Diplodacus signatifer*
Medial vitta on mesonotum broadening posteriorly and apex commencing level with suture; facial spot small, circular; medial black stripe on fifth tergite which may extend forward on to fourth tergite; no pecten on male abdomen; supernumerary lobe very weak and no microtrichia at extremity of vein $cu_1 + 1a$, in male ..... *Austrodacus cucumis*

19. Small flies, entirely black on mesonotum; lateral post-sutural stripes wanting ..... *Paratridacus niger*

Medium to large flies, predominantly fulvo-ferruginous on mesonotum; lateral post-sutural stripes present 20

20. Scutellum yellow except for narrow dark brown basal band; no infuscation on wing other than costal band and anal streak; weak, brown, medial stripe on posterior half of abdomen ..... *Paratridacus expandens* (teneral material)

Scutellum yellow except brown apical spot and narrow dark brown basal band; a band of infuscation on wing embracing *r–m* cross vein and outer portion of discal cell; broad, medial, fuscous brand running length of abdomen ..... *Neozeugodacus aureus*

21. Prescutellar bristles present 22

Prescutellar bristles absent 58

22. Post-sutural vittae wanting ..... *Strumeta mendosa*

Post-sutural vittae present 23

23. A medial yellow vitta in addition to lateral post-sutural vittae on mesonotum 24

Only lateral post-sutural vittae on mesonotum 26

24. *r–m* cross vein infuscated; notopleural calli dark brown ..... *Afrodacus furvus* (females)

No infuscation on *r–m* cross vein; notopleural calli yellow 25

25. Thorax wholly black (except yellow calli); black transverse band or lateral black spots on first and second tergites ..... *Afrodacus tigrinus* (females)

Thorax reddish-brown with darker or black markings behind suture; first and second tergites entirely yellowish ..... *Afrodacus flavinotus* (females)

26. Anterior supra-alar bristle present 27

Anterior supra-alar bristle wanting 54

27. Infuscation on wing other than costal band and anal streak 28

Wings not infuscated except for costal band and anal streak 30

28. Both *r–m* and outer median cross veins infuscated ..... *Strumeta strigatus*

Only one of these cross veins infuscated 29

29. *r–m* cross vein infuscated; pronounced facial spots ..... *Strumeta fuscatus*

Outer median cross vein infuscated; no facial spots ..... *Strumeta hispidula*

30. Scutellum brown or with black markings at apex 31

Scutellum wholly yellow on apical half 32

31. Lacking facial spots; scutellum uniformly chestnut brown; mesopleural stripe broad, almost attaining humeral callus ..... *Strumeta phaleriae*

Facial spots present; scutellum dark brown or black on apical third; mesopleural stripe narrow, about as wide as notopleural callus ..... *Strumeta bancroftii*

32. Costal cells brown; microtrichia covering greater part of second costal cell and a portion of first cell 33

Costal cells colourless or pale fulvous, never brown; microtrichia confined to outer portion of second costal cell only 37

33. Lateral post-sutural stripe ending beyond upper *p.sa.* bristle; costal band broad, crossing behind vein r_{2+3} for its entire length; first and second femora brown ..... *Strumeta notatagena* (teneral specimens)

Lateral post-sutural stripe ending before upper *p.sa.* bristle; costal band relatively narrow, crossing vein r_{2+3} only at its tip; first and second femora wholly or partly fulvous 34

34. Lacking facial spots; abdomen uniformly yellow-brown; lateral post-sutural stripe narrow, parallel-sided, almost attaining upper *p.sa.* bristle ..... *Strumeta mutabilis*

Large oval facial spots; abdomen fuscous or reddish-brown with fuscous markings; lateral post-sutural stripe broad, triangular, ending well before upper *p.sa.* bristle 35

35. Humeral callus brown or dark-brown ..... *Strumeta humeralis*
Humeral callus yellow 36

36. Mesonotum and abdomen chiefly red-brown but may be relieved with fuscous markings; mid and hind femora yellow to fulvous; costal band beyond tip of r_{2+3} narrower than stigma ..... *Strumeta tryoni*

Mesonotum and abdomen chiefly fuscous with a pattern of darker markings; apical half of mid and hind femora fuscous; costal band beyond tip of r_{2+3} broader than stigma ..... *Strumeta melas*

37. Mesonotum chiefly black 38

Mesonotum chiefly red-brown or with a pattern of fuscous markings 43

38. Abdomen with a pronounced broad medial black vitta on last three tergites; at least, fuscous on anterior portion of third and lateral margins of third and fourth tergites; lateral post-sutural stripe not broad, narrowing posteriorly and ending before upper *p.sa.* bristle 39

Abdomen without a broad medial black vitta, only occasionally a faint, narrow fuscous line; no fuscous on lateral margins of third and fourth tergites; lateral post-sutural stripe broad, almost parallel-sided and ending at or beyond upper *p.sa.* bristle 42

39. Facial spots linear, poorly defined; costal band broader than stigma; no pecten of hairs on third tergite and weakly developed supernumerary lobe in male ..... *Gymnodacus calophylli*

Facial spots oval or top-shaped; costal band not wider than stigma for its entire length; a pecten of hairs on third tergite and a definite supernumerary lobe in wing of male 40

40. Costal band broadening perceptibly at the extremity of r_{4+5}; mesonotum broadly reddish-brown bordering humeri and lateral post-sutural stripes ..... *Strumeta cacuminata* (melanic form)

Costal band of uniform width beyond the extremity of r_{2+3}; mesonotum black bordering humeri and lateral post-sutural stripes 41

41. Abdomen fulvous on last three tergites except for a medial, moderately broad, black stripe and fuscous to black on the anterior half of third and lateral margins of third and fourth tergites; mesonotum black; pleura red-brown beneath humeri and wings; only hind tibiae dark fulvous or brown ..... *Strumeta endiandrae*

Abdomen fuscous or black except for a very broad black medial stripe and red-brown on the central portions of fourth and fifth tergites; mesonotum black except red-brown centrally on posterior portion; pleura chiefly black; all tibiae dark fulvous or brown ..... *Strumeta silvicola* (melanic form)

42. Abdomen uniformly orange except anterior margins of first and second tergites tending fuscous; costal band narrower than stigma beyond extremity of vein r_{2+3}; mesopleural stripe about as wide as notopleural callus, straight sided; paired brown spots on fifth tergite ..... *Strumeta bancroftii* (form)

Abdomen orange-brown or reddish-brown except tending fuscous on anterior portions of first, second and third tergites; costal band at least as broad as stigma beyond extremity of vein r_{2+3}; mesopleural stripe slightly wider than notopleural callus and convex on anterior margin; no paired spots on fifth tergite ..... *Strumeta musae*

43. A well-defined, medial black vitta on abdomen, either as a band on the last three tergites or as an elongated spot on the posterior portion 44

No medial black vitta on abdomen 49

44. Last three abdominal tergites broadly fuscous on lateral margins and always fuscous on anterior half of third tergite 45

Last three abdominal tergites chiefly red-brown or ferruginous, not fuscous on lateral margins and only occasionally fuscous on anterior margin of third tergite 46

45. A medial (usually lanceolate) black pattern on mesonotum; costal band widening perceptibly as it crosses vein r_{4+5}; mesopleural stripe moderately broad, almost attaining anterior notopleural bristle above ..... *Strumeta cacuminata*

Mesonotum always red-brown medially; costal band parallel-sided beyond the tip of vein r_{2+3} and about as wide as stigma; mesopleural stripe narrow, almost parallel-sided, and approximating width of notopleural callus ..... *Strumeta silvicola*

46. Mesopleural stripe narrow, parallel-sided; lateral post-sutural stripe attaining upper *p.sa.* bristle; facial spot large, oval; apical half of each femur brown ..... *Strumeta quadrata*

Mesopleural stripe wider than notopleural callus, not parallel-sided; lateral post-sutural stripe not attaining upper *p.sa.* bristle; facial spot of medium size, almost circular; femora fulvous 47

47. Costal cells yellow or pale fulvous; medial stripe on last two abdominal tergites only; broad brown basal band on scutellum; aculeus distinctly lobed ..... *Strumeta bidentata*

Costal cells colourless; medial stripe on last three abdominal tergites; very narrow basal band on scutellum; aculeus not lobed 48

48. Lateral post-sutural stripe broad, near parallel-sided; mesonotum and abdomen chiefly pale red-brown, seldom marked with fuscous on mesonotum and then only laterally before suture and along inner margins of lateral post-sutural stripes ..... *Strumeta pallidus*

Lateral post-sutural stripe not broad, narrowing sharply posteriorly; mesonotum and abdomen rich red-brown, usually with a pair of longitudinal parallel black bands centrally on mesonotum ..... *Strumeta bilineata*

49. Paired dark brown to black spots on fifth tergite 50

No paired dark brown or black spots on fifth tergite 52

50. Mesopleural stripe broad, attaining at least anterior notopleural bristle anteriorly; facial spots circular; lateral post-sutural stripe broad, parallel-sided and attaining upper *p.sa.* bristle ..... *Strumeta robiginosa*

Mesopleural stripe narrow, not attaining anterior notopleural bristle anteriorly; facial spots elongate, pointed anteriorly; lateral post-sutural stripe narrow and ending before upper *p.sa.* bristle 51

51. Mesonotum and abdomen uniformly reddish-brown, rarely with narrow longitudinal fuscous bands on mesonotum; fuscous areas on extreme lateral margins of third and fourth tergites only; mesopleural stripe not wider than notopleural callus; lateral post-sutural stripe not broad and narrowing posteriorly ..... *Strumeta halfordiae*

Mesonotum red-brown with or without a pattern of fuscous markings; abdomen usually fuscous over most of third and fourth tergites and laterally on fifth; mesopleural stripe 1½ times width of notopleural callus; lateral post-sutural stripe parallel-sided for greater part of its length ..... *Strumeta kraussi*

52. Mesonotum dark red-brown with a pair of longitudinal fuscous bands ..... *Strumeta breviaculeus*

Mesonotum pale, uniformly reddish-brown or yellowish-brown, devoid of fuscous markings 53

53. Abdomen uniformly coloured, no fuscous markings; facial spot elongate, pointed anteriorly; visible portion of oviscape, *in situ,* more than twice as long as fifth tergite ..... *Strumeta fagraea*

Abdomen reddish-brown except fuscous laterally on third and fourth tergites; facial spot large, almost circular; visible portion of oviscape, *in situ,* much shorter than length of fifth tergite ..... *Strumeta barringtoniae*

54. *r–m* cross vein infuscated; mesopleural stripe L-shaped and reaching humeral callus ..... *Afrodacus brunneus*

No infuscation on *r-m* cross vein; mesopleural stripe not attaining humeral callus anteriorly 55

55. Humeral and notopleural calli joined by broad yellow band ..... *Afrodacus jarvisi*

Humeral and notopleural calli not joined by broad yellow band 56

56. Costal cells brown; microtrichia covering greater part of second costal cell and a portion of first cell; lacking facial spots ..... *Strumeta mutabilis* (some specimens)

Costal cells pale yellow or colourless; microtrichia in outer portion of second costal cell only; facial spots present 57

57. Mesonotum mostly black; lateral post-sutural stripes not broad, narrowing posteriorly and ending before upper *p.sa.* bristle; brown on apex of scutellum ..... *Afrodacus mesoniger*

Mesonotum chiefly red-brown; lateral post-sutural stripes very broad, parallel-sided and ending at or beyond upper *p.sa.* bristle; scutellum yellow ..... *Daculus murrayi* (some specimens)

58. Post-sutural vittae present on mesonotum 59

No post-sutural vittae on mesonotum 62

59. Medial post-sutural vitta on mesonotum 60

No medial post-sutural vitta on mesonotum ..... *Daculus murrayi*

60. Humeral and notopleural calli connected by yellow band ..... *Asiadacus strigifinis*

Humeral and notopleural calli not connected by yellow band 61

61. Mesopleural stripe broad, attaining humeral callus anteriorly; infuscation over central portion of wing; costal cells brown; microtrichia in first and second costal cells ..... *Daculus visendus*

Mesopleural stripe not attaining humeral callus anteriorly; central portion of wing hyaline; costal cells pale yellow; microtrichia only in outer portion of second costal cell ..... *Diplodacus signatifer* (some specimens)

62. *r–m* cross vein infuscated; broad mesopleural stripe attaining humeral callus anteriorly; abdomen fulvous with fuscous markings on first four tergites *Daculus exiguus*

r–m cross vein not infuscated; mesopleural stripe not attaining humeral callus anteriorly; abdomen uniformly coloured on first four tergites 63

63. Elongate facial spots; mesopleural stripe broad and attaining anterior notopleural bristle anteriorly; mesonotum uniformly dark brown; a fuscous mark in apical half of discal cell ..... *Dacus signatifrons*

No facial spots; mesopleural stripe narrow, slightly wider than notopleural callus; mesonotum rich chocolate brown except central elliptical yellow spot behind suture; central area of wing hyaline ..... *Dacus newmani*

VIII. PEST STATUS AND DISTRIBUTION

The fruit fly problem has proved a major hindrance to the economic stability of the fruit-growing industry in Queensland, chiefly by denying horticulturally suitable areas to commercial production and by the continued loss of fruit in commercial orchards and home gardens. In addition: "Quarantine restrictions and their implementation against fruit grown in Southern and Central Queensland, and in other areas where fruit fly occurs, have in recent years added considerably to the status of these pests" (May 1958*a*). Indeed, these have been troublesome facets of the fruit fly problem for more than half a century (Tryon 1889, 1894 *et seq.*, 1906, 1912; French 1898, 1907; Lea 1899; Quinn 1907; Jarvis 1922-1926; J. L. Froggatt 1928; Veitch 1934; Caldwell and May 1943; May and Caldwell 1944; May 1953, 1957*a*, 1958*a*, 1958*b*, 1958*c*, 1960; Swan 1949).

No attempt has been made to evaluate these several facets of the problem in terms of monetary losses to fruit-growers or the community. For the purposes of this paper, the economic status of a species has been assessed largely from records of damage to commercial fruits, host studies, field observations, marketing reports and Departmental records.

Eleven of the 54 species of Dacinae recognized in Queensland have been bred from commercial hosts (May 1953, 1957*a*, 1960); six of these are incidental pests and occur in association with the more important economic species or are recorded from commercial or ornamental hosts on infrequent occasions.

At times, larvae of other Diptera, usually *Atherigona* sp. (fam. Anthomyiidae), *Lonchaea aurea* Macq. (fam. Lonchaeidae) or *Rioxa pornia* (Walk.) (fam. Trypetidae), are found in commercial fruit. Larvae of these secondary pests often are mistaken for those of Dacinae (May 1958*a*).

Most Queensland locality records were obtained by itinerant trapping at trapping stations (a detailed account of locations and methods will be given in a later paper), and by breeding from hosts. Other records for this State were taken from information published by other authors (Tryon 1927; Hardy 1951), substantiated reports of damage to commercial fruit, and specimens and records held by this Department.

Records for Northern Australia, New South Wales and Victoria were obtained chiefly from specimens in the collections of the New South Wales Department of Agriculture, Victorian Department of Agriculture, Western Australian Department of Agriculture, C.S.I.R.O. Division of Entomology (Canberra), Australian Museum (Sydney), and National Museum (Melbourne); published records of the New South Wales Department of Agriculture (Insect Pest Survey) for the years 1947-1960; and specimens received for identification from the Northern Territory Administration.

Records for New Guinea have been taken from literature (Malloch 1939; Perkins 1939), and from specimens in the collection of the Department of Agriculture, Stock and Fisheries of the Territory of Papua and New Guinea.

Distributions of the better-known species are shown on maps: each location represents an authenticated record for the species. Where the number of locality records for a species is small, the data are presented in tabular form.

(a) Species of Major Importance

Strumeta tryoni

S. tryoni has been bred from 117 wild, ornamental and commercial hosts in Queensland (May 1953, 1957*a*, 1960) and is a pest in coastal, subcoastal and inland districts.

In coastal areas not subject to low winter temperatures, damage to fruit may occur in all months of the year, although the severity of damage fluctuates with the season and from year to year. Rarely are the more susceptible fruit that mature in summer and autumn months free from damage by this species. In years of good rainfall, serious losses of fruit are experienced in all but the coldest months in both coastal areas and districts several hundred miles inland (May 1958*a*).

Most susceptible commercial fruits produced in Queensland are grown in districts with temperatures at or below the threshold of activity for this species between late April and September. Thus most of the citrus and apples produced mature when fruit flies are not active. At other times of the year, the successful harvesting of fruit is assisted often by the occurrence of weather conditions unfavourable to fruit fly activity. These aspects of the ecology of *tryoni* will be discussed in a subsequent paper.

The recorded distribution of *tryoni* in Australia prior to 1900 has been given earlier. Centres where the species has been recorded since then are shown in Figure 13. The increase in locality records in the intervening period is explained chiefly by closer settlement, recognition following an increase in fly population, better facilities for identification of the pest and its damage and, in those areas of infrequent occurrence, transport by human agency.

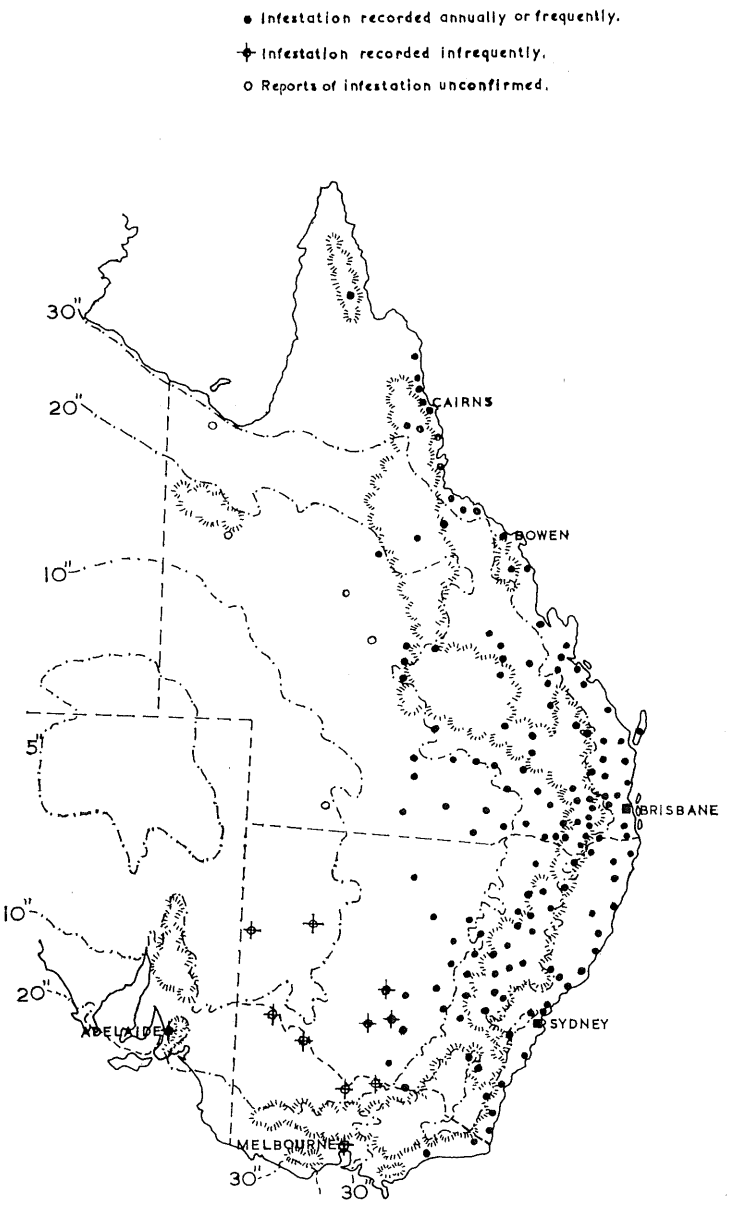

Fig. 13.—Locality records for *Strumeta tryoni* in eastern Australia.

The earliest records of fruit fly damage in Queensland, even in Australia, reflect the pattern of early settlement and the associated development of fruit-growing in areas culturally suitable. It is conceivable, as the early writings of Tryon (1889) and W. W. Froggatt (1909) have confirmed, that fruit-growers experienced losses from fruit fly long before the cause of the damage was recognized.

Tryon's familiarity with the problem in Queensland, as well as Froggatt's knowledge of the species at the time he compiled his 1909 paper, leave little doubt that both authors were discussing *tryoni*. A great many of the specimens bred by Tryon were retained and have been examined. The majority are *tryoni*.

Tryon's (1889) discovery of damage by *tryoni* at Toowoomba did not infer a centre of distribution for this pest but marked at least the commencement of authentic entomological records in Queensland. Subsequent records (Tryon 1894-1906) broadened the picture of distribution considerably.

We can conclude from Froggatt's and Tryon's reports that *tryoni* was an economic pest at that time in coastal and subcoastal districts from south of Sydney to northern Queensland. Reports of heavily infested fruit arriving in southern ports from Queensland and New South Wales prior to 1900 (Quinn 1907) confirm this. A general lack of early records masks the history of distribution in more inland areas where the species is known to occur today.

Many wild hosts of *tryoni* grow in the softwood scrubs on the western slopes of the Great Dividing Range in southern and central Queensland. It is conceivable that the pest is indigenous to these areas, for today it is endemic in Queensland inland to a line connecting Hughenden, in the north, Jericho, Augathella, Charleville and Cunnamulla. A report that fruit fly damages commercial fruit, chiefly citrus, at Thargomindah, in the extreme south-western corner of the State, could not be substantiated, although most areas of south-western Queensland receiving an average rainfall greater than 15 in. report fruit fly activity in favourable seasons (Departmental records). Traps maintained in recent years at Offham, 45 miles north-east of Cunnamulla, and at St. George, 120 miles south of Roma, recorded appreciable activity by *tryoni* throughout the year.

Few authentic records are available from the extreme central-western and inland north-western areas of the State. Reports of damage to commercial fruit at Jericho (1950) and Blackall (1953) were confirmed, although reports of fruit fly damage to cultivated fruit at Winton, Longreach, Cloncurry and Mt. Isa were not substantiated. Dipterous larvae infesting mangoes at Mt. Isa (January 1958) proved to be those of the Anthomyid *Atherigona* sp. Residents at Cloncurry and Mt. Isa and of homesteads in the sparsely populated cattle country to the north report no damage attributable to fruit fly in citrus and mango crops (personal communications).

Fruit fly damages fruit each season at Torrens Creek and also at Hughenden, 60 miles further west, though authentic records are not available for localities west of Hughenden. Several reliable reports of fruit fly damage to citrus were received from Burketown and Normanton, on the Gulf of Carpentaria (personal communications). Infested material was not obtained but it is most probable that *tryoni* and *humeralis* were the species implicated.

Host collections in 1957 recorded the presence of *tryoni* in the Coen area, Cape York Peninsula. Rain-forest extends northward from Coen and it may be assumed that this species is indigenous to the limits of the mainland. *S. tryoni* has not been recorded from islands in Torres Strait or on the New Guinea mainland. It does occur, however, on the larger offshore islands southward from Cairns.

Recently, the New South Wales Department of Agriculture reported that the species was well established on Lord Howe Island, approximately 400 miles east of Port Macquarie.

Only occasional records of fruit fly incidence are available for areas of northern Australia outside Queensland. One of these concerns *tryoni* and is a record of specimens identified from lure traps at Nightcliff, near Darwin, in 1961. Bioclimatic data, to be reported in a later paper, suggest that this species will be recorded from other areas of coastal northern Australia once these areas have been systematically collected.

Locality records cited by earlier writers (W. W. Froggatt 1909; Tryon 1927) and published records of the New South Wales Department of Agriculture (Insect Pest Survey 1947-1960) confirm the distribution of the species throughout the coastal and subcoastal region of New South Wales southward from Queensland to the Victorian border. Records of damage to fruit exist for most fruit-growing centres within 200 miles of the coast in the northern half of New South Wales. It can be assumed that the species is indigenous to the mountainous area within this region, for not only is Tenterfield the type locality for the species, but the pattern of distribution in northern New South Wales agrees with that suggested by distribution records for southern inland areas of Queensland.

The limits of natural distribution in central-western and north-western New South Wales are not clear. *S. tryoni* has been a pest of citrus for many years at Bourke, in the central northern region, and it is recorded frequently also from Cobar, Nyngan, Coonamble and Walgett. Damage is recorded often at Wilcannia and Menindee, on the Darling River in central-western districts. The species is recorded consistently at Broken Hill well within the 10-in. rainfall isohyet.

In southern New South Wales, infestations are never severe and it has been postulated by others that each infestation has arisen following introductions from coastal areas. The species is recorded frequently from many inland centres, including the Murrumbidgee Irrigation Area and Hillston, Hay, Lake Cargelligo

and Yenda, and occasionally infests fruit in the Murray Valley between Albury and Mildura. Such infestations are too general and widespread to have arisen solely from annual introductions.

S. tryoni is recorded frequently at Canberra in the late summer and autumn. It is claimed that the species is not indigenous to the area but is introduced annually in commercial fruit. Distribution records from the mountainous areas in the vicinity of Canberra are not available, though *tryoni* is recorded also from Tumut.

Infestation records are available from many centres on the eastern slopes of the Great Dividing Range in the south-eastern districts of New South Wales. These centres include Bega, Cooma, Delegate and Eden. *S. tryoni* has been taken also at several centres in East Gippsland, Victoria, and in favourable seasons damages commercial fruit in orchards near Bairnsdale and Orbost. Several wild hosts of *tryoni** have been recorded from the temperate rain-forests of the Otway Mountain and Lake King areas of eastern Victoria (Francis 1929). These and other wild hosts occur more commonly in the rain-forests of the Illawarra, Milton, Braidwood and Tilba Tilba districts of southern coastal New South Wales.

Distribution in the more southerly areas of the mainland was never studied until small infestations of *tryoni* were discovered at Adelaide and Melbourne in 1949. Infestations have recurred at these centres at frequent intervals, while less frequent infestations have been reported from several Victorian centres in the Murray River valley, notably Mildura and Shepparton. In all instances populations were small and the eventual history of each record is not known.

Strumeta humeralis

Perkins' fruit fly, a pest of commercial fruit in coastal districts of Queensland receiving an annual rainfall greater than 30 in., is more prevalent in North Queensland, where it is an important pest of citrus and tomato crops from December to April. This species has not been recorded in New South Wales, although it is highly probable that it occurs in the northern coastal areas. A specimen of *humeralis* in the University of Queensland collection was taken at Darwin. Locality records for Queensland are shown in Figure 14A.

Specimens of *humeralis* and *tryoni* are bred frequently from the same fruit (May 1953, 1957*a*). The latter is usually more prevalent, although hosts collected in autumn in North Queensland may yield a majority of *humeralis* or may be infested only by this species.

Despite a similar host range, the relative numbers of these two species taken at trapping stations differed considerably from station to station as well as between seasons at the same station. Trapping data indicated that *humeralis* is much

**Acronychia laevis* Forst., *Eugenia australis* Wendl. ex Link, *Notelaea longifolia* Vent., *Solanum laciniatum* Ait. (vide Francis 1929)

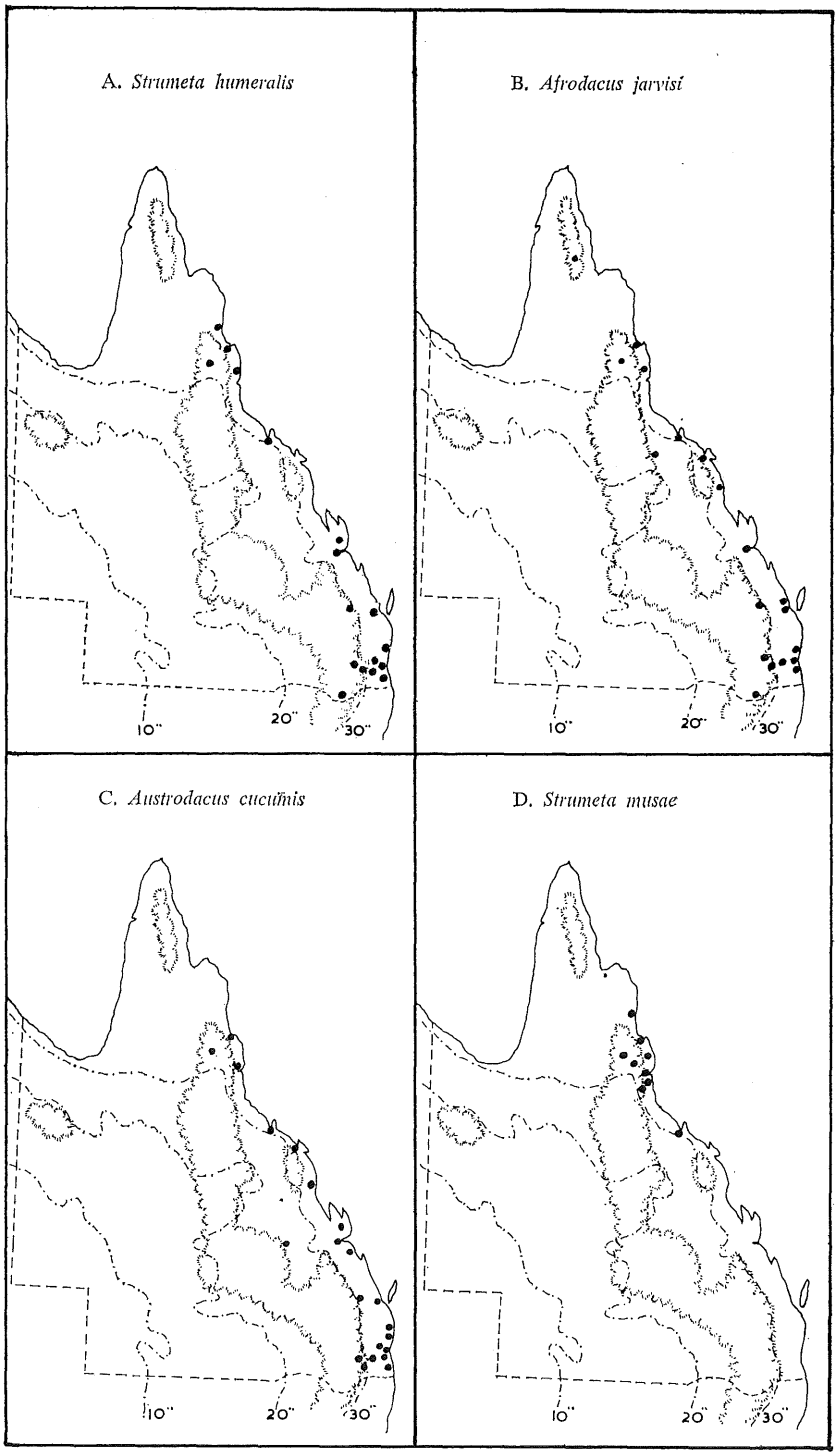

Fig. 14.—Locality records for *Strumeta humeralis, Afrodacus jarvisi, Austrodacus cucumis* and *Strumeta musae* in Queensland.

less prevalent in southern parts of the State, especially in the cooler highland districts. In these regions, *humeralis* is rarely taken in traps between April and September. It has never been recorded from inland districts.

When the numbers of *tryoni* and *humeralis* taken at each trapping station are compared as a ratio (Table 9), the distribution pattern of the two species can be appreciated. The ratio is narrowest for South Johnstone (0·59:1) and broadens to 1533.6:1 for Stanthorpe. Only seven specimens of *humeralis* were taken during four years' trapping at Stanthorpe.

TABLE 9

PREVALENCE OF *tryoni* AND *humeralis* AT TRAPPING STATIONS

Trapping Station	Years Traps Maintained	Numbers per Trap per Year			Summation of Mean Temperature and Mean Relative Humidity
		tryoni	*humeralis*	*tryoni*: *humeralis*	
South Johnstone	1956–59	4·4	7·4	0·59 : 1	157·9
Rita Is.	1956–59	37·6	25·1	1·5 : 1	
Kamerunga	1951–55	48·6	14·0	3·47 : 1	152·3
Ayr	1951–55	160·5	38·7	4·13 : 1	146·4
Maryborough	1956–59	34·97	7·9	4·43 : 1	144·0
Rockhampton	1953–56	222·1	36·8	6·04 : 1	139·2
Atherton	1954–58	301·9	44·6	6·77 : 1	145·1
Nambour	1951–52	148·1	15·1	9·8 : 1	140·6
Sunnybank	1953–56	734·1	59·0	15·31 : 1	137·0
Lawes	1949–56	1065·3	14·2	75·02 : 1	139·8
Gayndah	1944–46	550·1	6·6	83·35 : 1	136·0
Withcott	1953–55	231·2	2·6	88·92 : 1	
Toowoomba	1949–53	313·98	3·34	94·01 : 1	136·5
Stanthorpe	1953–57	191·7	0·175	1533·6 : 1	127·3
St. George	1959–60	231·0	..	..	120·9
Offham	1957–58	39·2	..	..	119·4

The relative abundance of these species at each trapping station expressed as a ratio bears a close relationship to the mean temperature and the mean relative humidity; this will be discussed in a subsequent paper.

Afrodacus jarvisi

Locality records for *Afrodacus jarvisi* in Queensland are shown in Figure 14B.

The first record for this species in Queensland is represented by a specimen in the collection of the Queensland Department of Agriculture and Stock labelled "*Dacus* sp., Rockhampton, 1912 ex *Careya australis* [=*Planchonia careya* (F. Muell.) R. Knuth]". In 1922 it was bred by Dr. T. Bancroft from the same host collected at Burnett Heads, near Bundaberg, and two years later by Jarvis from pears and quinces grown in the Stanthorpe District (Jarvis 1925*a*). Other early distribution records were for Bowen and Howard (Tryon 1927).

Jarvis' fruit fly has now been taken in most eastern coastal and subcoastal districts of Queensland, where it is a pest of mangoes, persimmons and stone and pome fruits in the late summer. The species is prevalent in open eucalyptus forest country in the coastal belt as far south as Bundaberg, breeding in its more usual wild host, *P. careya.*

The most northerly record is Coen, where specimens were bred in 1957 from the wild host *Eugenia suborbicularis* Benth. The most southerly record is Moorland (near Taree), N.S.W., where it was bred from mangoes and persimmons. It was bred also from mangoes from Coff's Harbour, N.S.W.

The recording of this species only in the late summer at Stanthorpe, approximately 300 miles south of the southern limit of distribution of its more usual wild host, *P. careya,* suggested to earlier workers that the species migrated southwards each season. However, this species is more abundant also in late summer in North Queensland, an activity governed by weather conditions. Locality records from Moorland and Coff's Harbour, approximately 350 miles south of the Queensland border, suggest that other wild hosts of this species, most probably *Eugenia* species, occur in southern Queensland and northern New South Wales. Within these areas commercial hosts now support this species from season to season.

A. jarvisi ranges throughout northern Australia and damages mangoes at Broome, W.A. Mangoes are attacked also in the Darwin area, while specimens have been bred from the wild hosts *E. suborbicularis* at Darwin and *P. careya* at Batchelor and Katherine in the Northern Territory.

The species has not been recorded outside Australia, although a myrtaceous plant very close botanically to *P. careya* occurs throughout the East Indies.

Austrodacus cucumis

Figure 14C depicts the distribution of *Austrodacus cucumis* in Queensland.

The economic importance of the cucumber fly was recognized soon after cucurbits were first grown commercially in Queensland. Infested cucurbits were intercepted at southern ports as early as 1906 (French 1907) and as late as 1947 (Victorian Department of Agriculture records). W. W. Froggatt (1909) reported breeding this species from tomatoes imported from Queensland.

A. cucumis is confined to the coastal and subcoastal districts of Queensland and attacks cucurbits, tomatoes and ripe papaws, being a major pest of these crops in coastal districts north from Rockhampton. Populations are smaller in southern Queensland, although appreciable damage to cucurbits and tomatoes may occur during late summer and autumn in years of good rainfall. Very occasional specimens are taken in traps at Toowoomba, while none have been recorded from the Stanthorpe area despite the cultivation of hosts of *cucumis* in both districts.

W. W. Froggatt (1909) reported breeding this species from cucumbers received from Coonamble in central northern New South Wales, though the origin of this fruit was not stated. This species has not been listed in the New South Wales Department of Agriculture records. It is most probable that *cucumis* is distributed widely in northern and north-western coastal districts of Australia. A report from Burketown (personal communication) states that cucumbers are damaged frequently by maggots; infested material could not be obtained. A specimen of *cucumis* held by C.S.I.R.O. (Canberra) was captured at Bell's Point, 80 miles east of Darwin.

Malloch (1939) identified a female trypetid as *Dacus* (*Zeugodacus*) *cucumis* French from Mondo (5,000 ft), Papua, 1934. Some doubt must exist concerning this identification until a male of this species has been taken from that locality. *A. cucumis* was not encountered by Perkins (1939) when examining large series of specimens from several collections which were taken in New Guinea.

Strumeta musae

Fruit fly specimens bred by Tryon from bananas collected at Gordonvale in 1909 and recorded as "*D. tryoni* var." (Departmental records) were, without doubt, *S. musae*. At that time, bananas exported from North Queensland to southern ports were usually infested (Quinn 1907) and Tryon (1912) later recognized the importance of the species concerned.

The banana fruit fly is indigenous to the coastal rain-forest areas north from Cardwell, where it constantly poses a threat to the banana-growing industry. Unlike *tryoni,* which oviposits in bananas only after they commence to colour on the bunch, *musae* will attack immature fruit. Infestation is promoted should fruit be damaged first by birds, chewing insects or mechanical means. Under such circumstances, all fruit in the same bunch may be stung before undamaged bunches nearby are attacked. The habit of ovipositing in immature fruit necessitates prompt harvesting and careful culling when fruit is being prepared and packed for market. The culling out of up to 5 per cent. of harvested fruit is not unusual under normal plantation management.

The unrestricted export of bananas from coastal North Queensland to more southerly areas has afforded every opportunity for this species to become established in the banana-growing districts of southern Queensland and northern New South Wales. No substantiated report of its occurrence in these areas has been obtained. Known localities for the species in Queensland are shown in Figure 14D.

A specimen in the collection of the New South Wales Department of Agriculture, labelled "ex cultivated banana, north coast of New South Wales, 15th October, 1929," is undoubtedly *musae*. It is suggested that the fruit was imported from North Queensland. More recently, specimens of *musae* received for identification from the New South Wales Department of Agriculture were

bred from bananas intercepted on November 27, 1957, at Nimbin in north-eastern New South Wales. These had been imported from North Queensland. One specimen, a male, taken in a trap at Ayr on November 21, 1956, may have been introduced from its natural habitat some miles to the north, as this species has not been recorded damaging bananas in the Ayr district. Information, to be presented in a later paper, concerning the prerequisite of high temperature combined with high humidity for breeding activity by *musae* substantiates the lack of authentic locality records south of Cardwell.

This species was identified among trypetid material from New Guinea. The specimens were bred from bananas grown at Lae.

(b) Species of Minor Importance

The six species listed below in order of decreasing importance as pests are taken quite frequently in traps in commercial orchards. At times one or more of these may be more prevalent than some of the major economic species.

Strumeta melas (Figure 15A).—Records include eight commercial hosts. These are also hosts of *tryoni,* which is always the dominant species among bred material or in traps. Specimens were recorded chiefly from coastal areas and were bred most frequently from citrus and the wild host *Passiflora alba* Link and Otto. Locality records follow a pattern similar to those for *humeralis,* which also has a somewhat similar host range. *S. melas,* however, was not prevalent at stations in areas of high rainfall and humidity nor in districts subject to low winter temperatures. Numbers of specimens recorded per trap per year for trapping stations at Atherton, Kamerunga, South Johnstone, Maryborough and Stanthorpe were 0·1, 0·4, 0, 0·6 and 0·3 respectively. In contrast, 6·3, 14·4, 19·3 and 4·1 specimens per trap per year were recorded at Gayndah, Sunnybank, Lawes and Toowoomba stations respectively (*cf.* relevant data for *humeralis* in Table 9).

Strumeta halfordiae (Figure 15B).—The halfordia fruit fly, an incidental pest in central and southern coastal districts, attacks citrus, loquat and some myrtaceous fruits and usually occurs in these hosts in association with the more prevalent *tryoni.* On occasions, *halfordiae* may attain some importance as a pest of citrus and it was bred in spring 1939 in large numbers from second-crop grapefruit in the Palmwoods district. Numbers are often high in traps in spring and early summer. *S. halfordiae* has been recorded from rain-forest areas of coastal New South Wales as far south as Gosford. Gurney (1910, 1911) bred large numbers from the wild host *Acronychia laevis* Forst. in the Gosford area, although there are no records of the species having been bred from citrus. This wild host is recorded from the Lake King district of East Gippsland, while another important wild host, *Planchonella australis* (R. Br.) Pierre, occurs as far south as Illawarra. Thus it is probable that *halfordiae* ranges further south than Gosford.

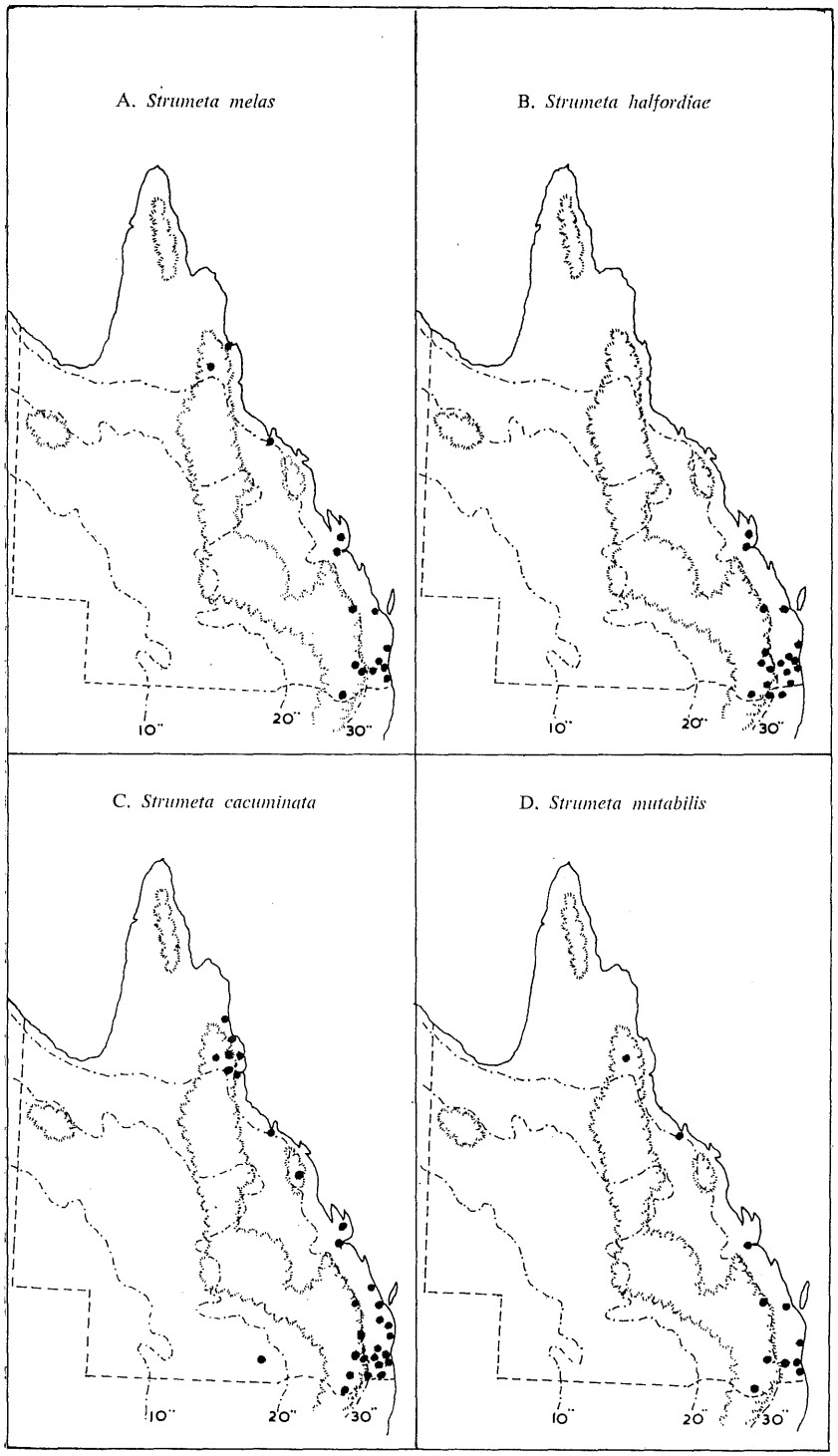

Fig. 15.—Locality records for *Strumeta melas, S. halfordiae, S. cacuminata* and *S. mutabilis* in Queensland.

Strumeta bilineata.—*S. bilineata* was bred by Tryon in 1924 from apricots at Warwick (Departmental records) but was grouped with specimens of *tryoni.* A few specimens, with greater numbers of *tryoni,* were bred by the author from the same host at Toowoomba in 1940 (May 1953). This association was not repeated in subsequent years although small numbers of *bilineata* were taken in traps in the same orchards each spring and early summer. This species was at times prevalent among material from trapping stations, especially those situated near rain-forest, and was recorded regularly or bred from hosts at many centres in coastal southern Queensland. It was taken in traps also at Gayndah, Rockhampton, Byfield, Ayr, Cairns and Atherton districts. *S. bilineata* has not been recorded from New South Wales, although the wild host *Planchonella pohlmanianum* (F. Muell.) Pierre ex Dubard has been recorded from the Tweed River district.

Strumeta cacuminata (Figure 15C).—This species is merely of incidental economic importance. Tryon (1927), when recording hosts of the species, mentioned the usual wild hosts 'and exceptionally Capsicum (especially *C. grossum,* the giant capsicum) the "chili" of Australia and "pepper" of elsewhere'. These commercial hosts were not recorded for *cacuminata,* although *tryoni* was often bred from giant capsicum. A few specimens were bred from tomato at Nambour in 1939. No further records have been made for tomato, although large field populations of *cacuminata* are known to occur throughout the tomato-producing areas of coastal and subcoastal Queensland. Fruit fly damage to tomatoes in these areas is due invariably to *cucumis, humeralis* or *tryoni.* Allman (1939) had induced *cacuminata* to breed in tomato under laboratory conditions but this behaviour was not recorded during species-host studies in Queensland.

Tryon retained specimens—labelled *"Dacus*?" (Department collection)—captured at Bowen in 1909 "feeding on maize secretion near cucumbers". Other records of Tryon and information in his 1927 paper reveal that *cacuminata* was always prevalent along coastal Queensland and extended southward to Sydney. With one exception, locality records embrace coastal and subcoastal districts between Mossman and the southern border and highlands. The species was taken in traps at St. George, approximately 250 miles inland. It is most probable that *cacuminata* occurs also at other inland centres, at least to the western slopes of the Great Dividing Range.

The repeated occurrence of this species in traps at Stanthorpe, on the southern highlands, despite the absence in this district of its usual host *Solanum auriculatum* Ait., had suggested to earlier workers that the species continually entered the district from areas of rain-forest some 30 miles to the south-east and north-east. This supposed ability to migrate appreciable distances prompted the theory that *tryoni* also entered this district from coastal areas. The presence of *cacuminata* at St. George points to the existence of another host, most probably one or more of the many native solanums in this area.

Records of the New South Wales Department of Agriculture (Insect Pest Survey) reveal that this species is prevalent in the northern and central coastal districts of New South Wales, being recorded from Murwillumbah, Mullumbimby, Macksville, Turramurra and Sydney. *S. cacuminata* has been identified by the author among material trapped in East Gippsland, Vic. Records reveal a wide distribution in eastern Australia, although no evidence was obtained that the species occurred in coastal areas of Northern Australia or in New Guinea.

Strumeta mutabilis (Figure 15D).—This species is more prevalent in southern coastal districts. Numbers taken in traps at Lawes and Toowoomba are often large during spring and early summer. Wild hosts of this species are not known. One specimen among a large number of *tryoni* was bred from kumquat at Grantham. Infested fruit of this host have been collected on subsequent occasions but *mutabilis* was not recovered among the bred material and the species can be considered of little or no economic importance.

Callantra aequalis.—Several specimens bred from orange at Gosford, New South Wales, provided the type material for Coquillet's description of the species (W. W. Froggatt 1909). No commercial host records were compiled during these studies and it must be presumed that *aequalis* is of little or no commercial importance. The species is frequently taken in traps in coastal areas south from Rockhampton and has been recorded also from Atherton, Ayr and Byfield.

Apart from the Gosford record cited above, no locality records have been published for this species in New South Wales. The wild host *Marsdenia rostrata* R. Br. is recorded for rain-forest areas as far south as East Gippsland, Victoria.

(c) Species of No Economic Importance

The following species have not been bred from commercial hosts in the field and are considered of no economic importance. Several are relatively abundant in the field and may be obtained in large numbers in traps or from hosts. The genera and species are listed alphabetically. Where only a few locality records are available for a species, these are given in Table 10.

Afrodacus brunneus.—Hosts are not known, although large numbers may be taken in traps in citrus orchards in south-eastern Queensland, newly emerged flies being recorded between November and February. The species was recorded in traps at Brookfield, Gayndah, Lawes, Stanthorpe, Sunnybank, Toowoomba and Withcott. Occasional specimens were taken at Atherton in midsummer. It has not been recorded from New South Wales.

Afrodacus mesoniger.—Specimens were taken in traps at centres in coastal and subcoastal districts between Atherton and Cairns in the north and the southern border. None was recorded at Stanthorpe and only occasional specimens were taken at Toowoomba. The species was bred from the wild host *Litsea reticulata* (Meissn.) Benth., collected at the Bunya Mountains, 100 miles north-west from

TABLE 10

LOCALITY RECORDS OF OTHER QUEENSLAND DACINAE

Species	Locality											
	Mossman	Cairns	Atherton	South Johnstone	Tully	Ayr	Rockhampton	Byfield	Nambour	Brisbane	Gatton	Toowoomba
Afrodacus flavinotus			+									
Afrodacus furvus			+									
Afrodacus tigrinus		+	+									
Callantra auricoma			+			+						
Callantra petioliforma						+	+				+	
Daculus exiguus			+									
Daculus murrayi		+										
Daculus visendus		+	+									
Dacus signatifrons										+		
Neozeugodacus aglaiae	+	+	+	+	+							
Neozeugodacus aureus										+	+	+
Paratridacus expandens	+	+										
Strumeta alyxiae	+	+	+			+						
Strumeta amplexiseta			+									
Strumeta barringtoniae		+	+			+						
Strumeta bidentata		+						+				
Strumeta breviaculeus		+	+	+		+		+				
Strumeta fagraea	+	+	+	+	+							
Strumeta hispidula			+			+						
Strumeta mendosa			+									
Strumeta notatagena		+	+	+								
Strumeta phaleriae	+											
*Strumeta pulcher**			+						+			
Strumeta quadrata			+		+	+		+		+		
Strumeta recurrens	+	+	+		+							
Strumeta robiginosa						+						
Strumeta silvicola			+			+		+				
Zeugodacus choristus		+	+	+		+	+	+	+		+	

* Recorded also from Glasshouse Mountains (type locality)

Brisbane. This species has not been recorded south of the Queensland border, though several wild hosts (*Litsea* species) of *mesoniger* grow in rain-forests as far south as Gloucester and Taree, in the central coastal districts of New South Wales.

Asiadacus s. strigifinis.—Specimens were taken in traps at Atherton, Cairns, South Johnstone and Rita Island (at the mouth of the Burdekin River). The species was described by Walker from the Moluccas (Hardy 1959). Perkins (1939) erected his species *lanceolatus,* a synonym of *s. strigifinis,* on specimens from several centres in the Owen Stanley Ranges, New Guinea. Malloch's (1939) species *albolateralis,* also a synonym of *s. strigifinis,* was taken from the same area of New Guinea.

Dacus absonifacies.—Only occasional specimens were bred from the wild host *Marsdenia rostrata* collected near Brisbane. The species was taken during spring and early summer at Lawes, Stanthorpe, Sunnybank and Toowoomba. One specimen was taken at Atherton. Specimens in the collections of the Victorian Museum (Melbourne) and the C.S.I.R.O. Division of Entomology (Canberra), were captured at Mallacoota and Noorinbee, East Gippsland, Vic., respectively. A specimen taken in a trap at Bairnsdale, also in East Gippsland, was identified as *absonifacies* by the author among trypetid material received from the Victorian Department of Agriculture. This species is taken also in traps at centres in coastal regions of New South Wales. The host *M. rostrata* has been recorded from the Hunter River (N.S.W.) and East Gippsland areas.

Dacus newmani.—*D. newmani* was taken in 1928 in traps at Pozieres, Stanthorpe district (Departmental records). No further records were made until these studies commenced, when the species was recorded in traps at Lawes, Stanthorpe, Toowoomba and Offham, near Cunnamulla, south-western Queensland. The species has not been recorded from coastal districts, a distribution pattern quite unrelated to that of any other Queensland species of Dacinae. *D. newmani* was described by Perkins (1937) from material bred in 1918 from a native fruit collected at Carnarvon, Western Australia. It has been recorded quite frequently in recent years in traps in the Adelaide Hills district, South Australia (personal communication). Specimens of this species were received for identification in 1962 from traps at Broken Hill and Menindee, N.S.W. (New South Wales Department of Agriculture) and from traps in citrus orchards at Alice Springs, Central Australia (C.S.I.R.O.). These records suggest a distribution throughout areas of Australia receiving an average rainfall between 10 and 30 in. per annum.

Diplodacus signatifer.—Tryon (1927) recorded this species from a native *Capparis* collected at Bowen in 1915 and 1926. Hardy (1951) recorded it from Cairns and Mowbray River. Locality records have since been obtained for Mossman and Ayr. The host *Capparis lucida* (DC.) R.Br. ex Benth. is recorded from Port Molle, near Proserpine, and it is probable that *signatifer* extends southward to this area. The northern limit of distribution is not known.

Gymnodacus calophylli.—This species has been recorded from many centres on the coastal plain between Ayr and Mossman and can be bred in large numbers from its host, *Calophyllum inophyllum* L. One specimen was taken in a trap at Atherton. Hardy and Adachi (1954) recorded *calophylli* from Singapore, Malaya, ex *C. inophyllum*. This host is recorded also from India. *G. calophylli* has not been recorded from coastal areas of Northern Australia.

Paratridacus niger (Figure 16A).—This is a common species in coastal and subcoastal districts from Mossman in the north to the southern border and inland to Stanthorpe. It has been recorded from Sydney, N.S.W. (Hardy 1951). Its wild hosts, *Olea paniculata* R. Br. and *Symplocos thwaitesii* F. Muell., are recorded from the Hunter River and Hastings River districts, N.S.W., respectively.

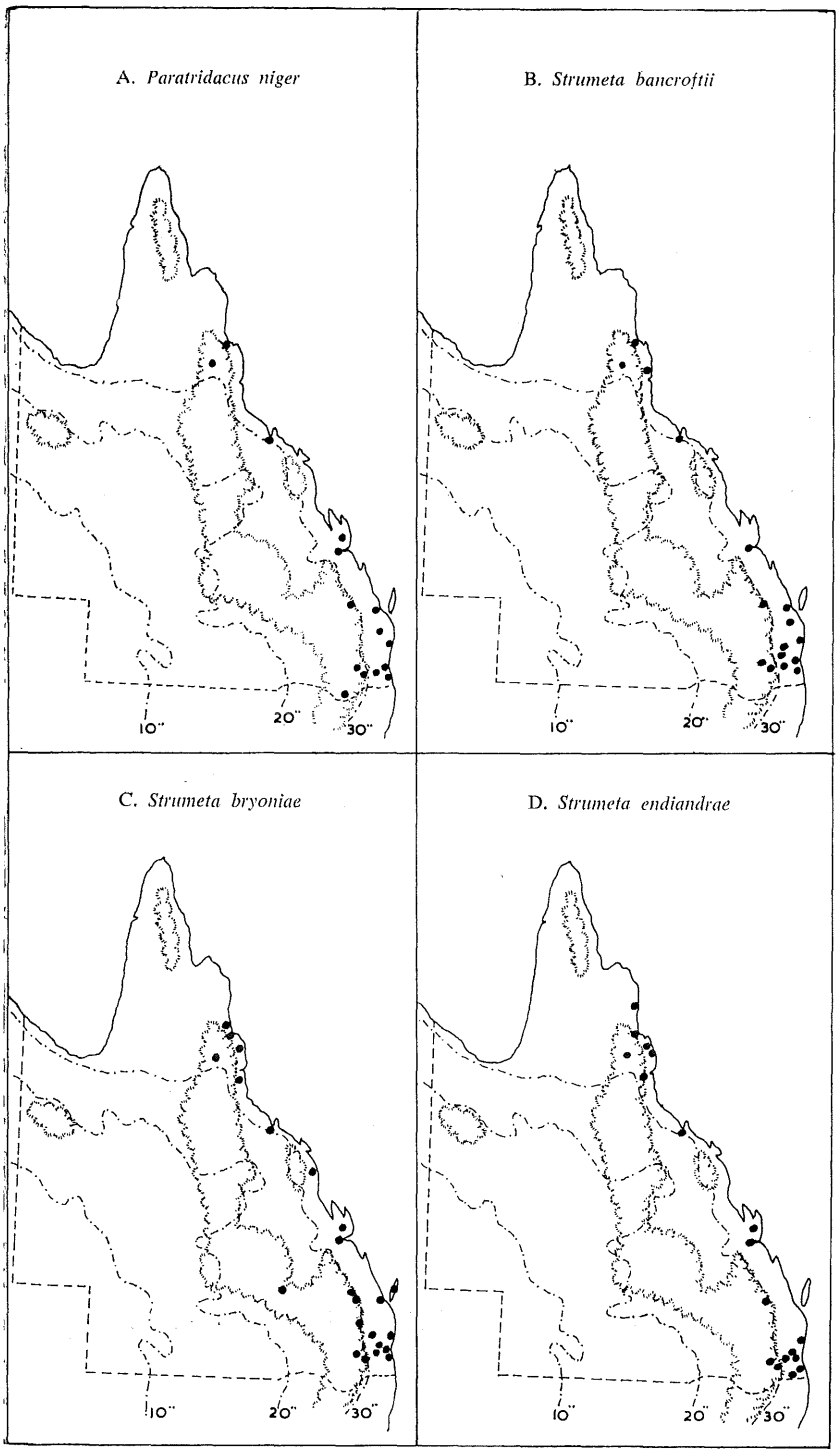

Fig. 16.—Locality records for *Paratridacus niger, Strumeta bancroftii, S. bryoniae* and *S. endiandrae* in Queensland.

Strumeta bancroftii (Figure 16B).—An unnamed specimen in the collection of the Queensland Department of Agriculture and Stock, bred from *Cudrania javanensis* Trécul at Gympie in 1926, is the first record of this species from Queensland. Tryon (1927) recorded an association between this host and *bancroftii* in coastal districts from Brisbane to the Herbert River, North Queensland. More recent records extend this range northward to Mossman, southward to Gosford, N.S.W., and inland to the Atherton Tableland in North Queensland and the highlands of southern Queensland. *S. bancroftii* was not taken in traps at Toowoomba or Stanthorpe, though specimens frequently were bred from its wild host growing on the eastern slopes of the Dividing Range between Toowoomba and Crows Nest, 25 miles to the north. *C. javanensis* grows also in North Australia and islands of the East Indies. *S. bancroftii* has not been recorded from these areas.

Strumeta bryoniae (Figure 16C).—This is a common species during winter months in coastal districts. Specimens were bred from the wild host *Bryonopsis laciniosa* (L.) Naud. collected in late autumn 1952 in softwood scrub north of Injune. This host is recorded from many localities towards the headwaters of the Fitzroy and Burdekin River systems (records of Botany Section, Queensland Department of Agriculture and Stock). No records can be found for New South Wales. Specimens received for identification from the Agriculture Branch, Northern Territory Administration, and taken in traps at Nightcliff, near Darwin, included *bryoniae.* The species ranges far to the north of Australia, being recorded from Dutch New Guinea (Perkins 1939) and Formosa (Shiraki 1933). *S. bryoniae* may be taken in large numbers in traps in North Queensland. No field records of damage to commercial hosts were obtained, although cucumbers were stung and larvae reared to maturity in the laboratory. Specimens received from the Department of Agriculture, Forestry and Fisheries, Territory of Papua and New Guinea, and bred from fruits of the bird's eye chilli (*Capsicum* sp.) at Milne Bay, Papua, were identified as *bryoniae,* although they differed slightly from the Queensland form in colour of the fore and middle tibiae.

Strumeta endiandrae (Figure 16D).—*S. endiandrae* may be taken in large numbers in traps in northern and central coastal districts and on the Atherton Tableland. It breeds readily in fruits of many species of *Endiandra,* a genus encountered in rain-forests between Gosford, N.S.W., and the Daintree River, North Queensland. The species has not been recorded from New South Wales.

Strumeta fuscatus (Figure 17A).—This species was recorded only from North Queensland. Its host, *Planchonella obovata* (R. Br.) H. J. Lam, is recorded from Byfield, near Rockhampton, but fruit collected in this area was not infested.

Strumeta kraussi (Figure 17B).—Though *kraussi* has an affinity with *halfordiae* in both host relationships and morphological characters, the species have quite dissimilar distribution patterns. *S. kraussi* is confined to the wet coastal and subcoastal rain-forests extending northwards from Townsville. The ranges of these two species do not overlap.

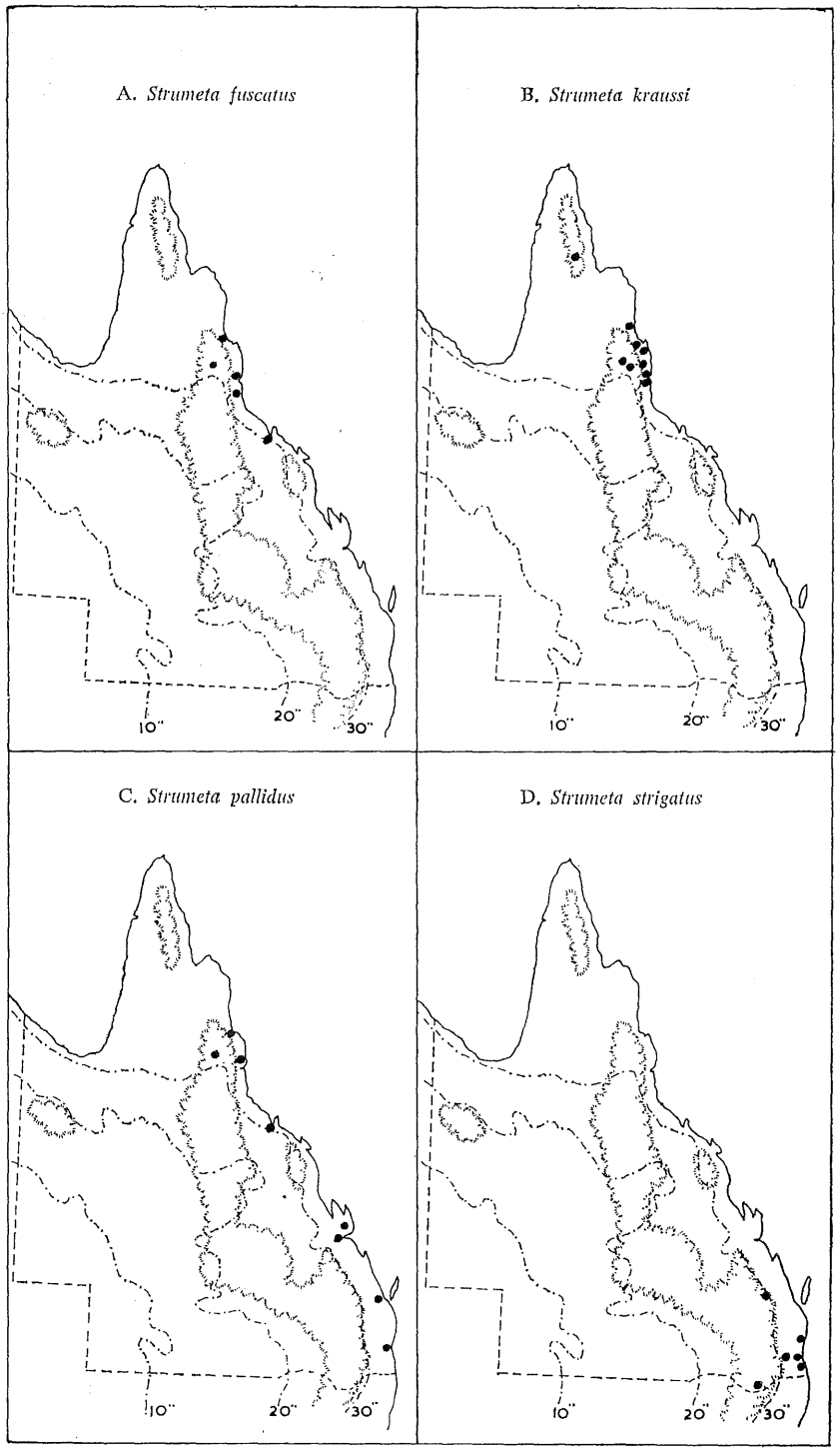

Fig. 17.—Locality records for *Strumeta fuscatus, S. kraussi, S. pallidus* and *S. strigatus* in Queensland.

Strumeta pallidus (Figure 17C).—A small series of specimens in the University of Queensland collection was recorded from Brisbane. Only very occasional specimens were taken in traps at Maryborough, Atherton, Rockhampton and Byfield. *S. pallidus* is very prevalent, however, in coastal northern Queensland, especially at Ayr. The only known host, *Nauclea orientalis* L., is indigenous to coastal areas from near Gladstone, Qld., to the Kimberley District, W.A. This ornamental tree has been planted in coastal districts southward from Gladstone to Brisbane. There is every likelihood that *S. pallidus* occurs in coastal districts of Cape York Peninsula and Northern Territory. Specimens trapped at Ivanhoe Station (Kimberley district), and Ord River, W.A., and received for identification from the Western Australian Department of Agriculture, were *pallidus*. The species has not been recorded outside Australia.

Strumeta strigatus (Figure 17D).—Though recorded only from south-eastern Queensland, the species has been identified also from Kulnura and Narara, near Gosford, N.S.W., and from Bairnsdale, Vic. No hosts have been recorded for this species in Queensland, although specimens received for identification from the Victorian Department of Agriculture had been bred from *Eugenia* sp.

Other.—Locality records for those species not discussed above are presented in Table 10. Some of the species have been recorded from centres outside Queensland. *Daculus murrayi* was described from Murray Island and Banks Island, Torres Strait. *Paratridacus expandens* is distributed widely throughout the East Indies and southern and Eastern Asia, having been identified from Aroe Island, Borneo, Philippine Islands (Bataan and Luzon), Malaya, India, Ceylon and Japan. *Zeugodacus choristus* was among specimens received for identification from Aiyura, New Guinea.

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Locality records were obtained from private correspondents. In many instances, specimens were forwarded.

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APPENDIX 1

SOME MEASUREMENTS OF EITHER TYPES OR PLESIOTYPES OF DACINAE OCCURRING IN QUEENSLAND

(Where measurements were from the type, the species is marked with an asterisk)

Species	Length of antenna (mm)			Vertical length of head (mm)	Length of face (mm)	Length of 2nd costal cell : length of stigma	*r-m* dividing m_{1+2}	Length of anal cell extension: length of $cu_1 + 1a$	
	Seg. 1	Seg. 2	Seg. 3					♀	♂
Afrodacus brunneus	0·13	0·15	0·58	1·45	0·4	0·6 : 1	1·2 : 1	1·8 : 1	2·3 : 1
*flavinotus**	0·1	0·18	0·4	1·1	0·4	0·7 : 1	1·4 : 1	0·9 : 1	..
*furvus**	0·1	0·15	0·32	1·1	0·3	0·8 : 1	1·2 : 1	0·7 : 1	2·5 : 1
jarvisi	0·23	0·25	0·75	1·6	0·55	0·6 : 1	1·6 : 1	1·4 : 1	2·5 : 1
mesoniger	0·15	0·2	0·65	1·5	0·45	0·7 : 1	1·3 : 1	1·3 : 1	2·4 : 1
*tigrinus**	0·1	0·2	0·4	1·1	..	0·7 : 1	1·4 : 1	0·5 : 1	2·0 : 1
Asiadacus s. strigifinis	0·2	0·2	0·7	1·3	0·4	0·7 : 1	1·4 : 1	1·1 : 1	2·7 : 1
Austrodacus cucumis	0·18	0·18	0·75	1·7	0·6	0·7 : 1	1·8 : 1	0·96 : 1	1·0 : 1
Callantra aequalis	0·33	0·35	1·2	2·1	0·75	0·8 : 1	1·9 : 1	1·8 : 1	2·8 : 1
*auricoma**	0·58	0·63	1·6	2·3	0·8	0·9 : 1	2·3 : 1	2·4 : 1	4·5 : 1
*petioliforma**	0·5	0·5	1·2	1·9	0·7	0·9 : 1	1·5 : 1	..	3·6 : 1
*Daculus exiguus**	0·1	0·2	0·6	1·2	0·45	0·9 : 1	2·1 : 1	..	0·45 : 1
murrayi	0·23	0·23	0·85	1·7	0·6	0·6 : 1	1·6 : 1	1·64 : 1	2·6 : 1
visendus	0·23	0·23	0·83	1·7	0·5	0·76 : 1	0·84 : 1	1·3 : 1	1·6 : 1
*Dacus absonifacies**	0·2	0·3	0·7	1·6	0·5	0·7 : 1	1·6 : 1	1·6 : 1	2·3 : 1
newmani	0·13	0·2	0·75	1·63	0·6	0·8 : 1	2·0 : 1	1·2 : 1	2·1 : 1
*signatifrons**	0·2	0·28	0·8	1·7	0·6	0·7 : 1	1·7 : 1	..	2·5 : 1
Diplodacus signatifer	0·13	0·2	0·6	1·5	0·45	0·6 : 1	1·7 : 1	1·1 : 1	2·8 : 1
Gymnodacus calophylli	0·15	0·18	0·7	1·6	0·48	0·8 : 1	1·8 : 1	0·7 : 1	0·7 : 1
Neozeugodacus aglaiae	0·25	0·25	0·83	1·68	0·45	0·63 : 1	1·4 : 1	1·3 : 1	1·7 : 1
aureus	0·2	0·2	0·88	1·63	0·5	0·61 : 1	1·5 : 1	1·6 : 1	2·3 : 1
Paratridacus expandens	0·23	0·33	0·98	1·95	0·58	0·63 : 1	1·5 : 1	1·1 : 1	1·37 : 1
niger	0·13	0·15	0·75	1·3	0·43	0·58 : 1	1·4 : 1	0·77 : 1	0·73 : 1
Strumeta alyxiae	0·23	0·3	0·82	1·6	0·43	0·7 : 1	1·2 : 1	1·4 : 1	2·5 : 1
*amplexiseta**	0·25	0·35	0·85	1·8	0·6	0·8 : 1	2·1 : 1	..	2·4 : 1
bancroftii	0·23	0·3	0·75	1·6	0·43	0·6 : 1	1·4 : 1	1·5 : 1	3·0 : 1
barringtoniae	0·2	0·25	0·8	1·5	0·45	0·5 : 1	1·4 : 1	1·2 : 1	2·5 : 1
*bidentata**	0·16	0·27	0·7	1·5	0·46	0·63 : 1	1·8 : 1	1·3 : 1	2·1 : 1
*bilineata**	..	..	..	..	..	0·6 : 1	1·4 : 1	1·6 : 1	2·4 : 1

APPENDIX 1—*continued*

SOME MEASUREMENTS OF EITHER TYPES OR PLESIOTYPES OF DACINAE OCCURRING IN QUEENSLAND—*continued*

(Where measurements were from the type, the species is marked with an asterisk)—*continued*

Species	Length of antenna (mm)			Vertical length of head (mm)	Length of face (mm)	Length of 2nd costal cell : length of stigma	*r-m* dividing m_{1+2}	Length of anal cell extension : length of $cu_1 + 1a$	
	Seg. 1	Seg. 2	Seg. 3					♀	♂
Strumeta									
breviaculeus	0·18	0·23	0·6	1·4	0·4	0·6 : 1	1·5 : 1	1·4 : 1	2·0 : 1
bryoniae	0·25	0·28	0·9	1·9	0·5	0·7 : 1	1·5 : 1	1·4 : 1	2·4 : 1
cacuminata	0·18	0·23	0·7	1·6	0·45	0·6 : 1	1·7 : 1	1·1 : 1	2·6 : 1
*endiandrae**	0·2	0·2	0·7	1·5	0·43	0·83 : 1	1·5 : 1	1·3 : 1	2·1 : 1
fagraea	0·25	0·25	0·8	1·6	0·48	0·64 : 1	1·6 : 1	1·7 : 1	2·2 : 1
fuscatus	0·2	0·2	0·8	1·4	0·45	0·7 : 1	1·25 : 1	1·3 : 1	2·3 : 1
halfordiae	0·18	0·2	0·8	1·5	0·48	0·6 : 1	1·6 : 1	1·5 : 1	1·9 : 1
*hispidula**	0·15	0·23	0·67	1·3	0·5	0·64 : 1	1·8 : 1	1·1 : 1	1·2 : 1
humeralis	0·2	0·23	0·78	1·5	0·4	0·6 : 1	1·5 : 1	1·7 : 1	3·3 : 1
kraussi	0·2	0·2	0·7	1·4	0·4	0·6 : 1	1·5 : 1	1·4 : 1	2·0 : 1
melas	0·2	0·25	0·8	1·6	0·45	0·65 : 1	1·7 : 1	1·8 : 1	3·2 : 1
*mendosa**	..	..	..	1·8	0·4	0·7 : 1	1·4 : 1	1·5 : 1	..
musae	0·2	0·25	0·7	1·6	0·45	0·6 : 1	1·6 : 1	1·8 : 1	2·6 : 1
mutabilis	0·23	0·25	0·8	1·6	0·4	0·7 : 1	1·75 : 1	1·5 : 1	2·3 : 1
*notatagena**	0·2	0·3	0·7	1·3	0·4	0·7 : 1	1·4 : 1	1·4 : 1	2·1 : 1
*pallidus**	0·23	0·25	0·7	1·5	0·45	0·7 : 1	1·5 : 1	1·25 : 1	2·5 : 1
*phaleriae**	0·15	0·25	0·6	1·5	0·5	0·65 : 1	1·9 : 1	1·3 : 1	2·2 : 1
pulcher	0·33	0·48	0·8	1·8	0·43	0·7 : 1	0·74 : 1	1·4 : 1	2·4 : 1
*quadrata**	0·21	0·36	0·72	1·6	0·5	0·63 : 1	1·7 : 1	..	2·7 : 1
recurrens	0·18	0·23	0·68	1·5	0·43	0·7 : 1	0·94 : 1	1·5 : 1	3·5 : 1
*robiginosa**	0·3	0·4	0·8	1·8	0·6	0·7 : 1	1·4 : 1	1·14 : 1	..
*silvicola**	0·15	0·3	0·68	1·4	0·4	0·6 : 1	1·5 : 1	..	2·5 : 1
strigatus	0·13	0·18	0·5	1·4	0·45	0·7 : 1	3·7 : 1	1·1 : 1	1·4 : 1
tryoni	0·23	0·25	0·75	1·6	0·5	0·6 : 1	1·7 : 1	1·5 : 1	3·1 : 1
Zeugodacus									
*choristus**	0·18	0·23	0·75	1·7	0·58	0·67 : 1	1·3 : 1	1·4 : 1	2·9 : 1

APPENDIX 2

Tryon (1927) confused *halfordiae* and *tryoni* when compiling his host list for the latter species; *humeralis* was also confused with *tryoni* (Tryon's specimens and records, Queensland Department Agriculture and Stock), although W. W. Froggatt (1909) had recognized colour differences between these two species. The true status of *humeralis* was not recognized for many years and Tryon's allotype for his *tryoni* var. *sarcocephali* in the Queensland Museum is *humeralis.*

Taxonomic and ecological studies suggest a close relationship between some species of Queensland Dacinae. The more obvious are the "tryoni complex" comprising *humeralis, melas* and *tryoni,* and *halfordiae* and *kraussi* (and possibly *fagraea*). These groupings embrace species that are close morphologically and are separated chiefly on colour and colour patterns.

Hardy (1951), dealing with teneral material, and being unable to find morphological characters to separate *humeralis* and *melas* from *tryoni,* considered these merely melanic forms and preferred to treat them as varieties of *tryoni.* Exley (1955) suggested a close relationship between *tryoni* and *halfordiae* based on larval characters. Host studies (May 1953) revealed somewhat similar host ranges for *humeralis, melas* and *tryoni* as well as *halfordiae* and *kraussi.* Several of these species have been bred at the same time from the one host.

Experiments were conducted in the laboratory to attempt to interbreed these and other species. Pure colonies of *cacuminata, cucumis, halfordiae, humeralis,* and *tryoni* were used; *tryoni* and *humeralis* were mated on five separate occasions, while all others were mated in turn with *tryoni* once only. In all instances, a two-way crossing of sexes within each pair of species was made. Fifty individuals of each sex were involved in paired trials. Pupae, obtained from a pure colony, were placed singly in tubes with moistened sawdust to maintain humidity. Tubes were plugged with cotton wool. As flies emerged, they were sexed, checked for species and placed in the respective cage, which measured 12 in. x 18 in. x 15 in., and held there for three months under conditions suited to the mating and breeding of each species when maintained as pure colonies. Sugar, MRT * and moisture were provided. Bananas, tomatoes, or cucumbers were placed in cages every second or third day. When eggs were deposited, the fruit was removed and held in muslin-covered breeding jars. On occasions, eggs were dissected from the tissues and held on moistened black filter paper in petri dishes in an incubator. Ovipositing was recorded in all trial crossings but none of the eggs was viable.

*A fully soluble enzymatic yeast hydrolysate containing free amino acids, polypeptides with all factors of the vitamin B complex

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