STUDIES IN AUSTRALIAN EMBIOPTERA.

PART III: REVISION OF THE GENUS METOLIGOTOMA, WITH DESCRIPTIONS OF NEW SPECIES,
AND OTHER NOTES ON THE FAMILY OLIGOTOMIDAE.

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(120 Text-figures and 3 Maps.)

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Since the completion of Parts i and ii of this series (Davis, 1936a, b), a considerable amount of fresh material has been obtained, particularly of the genus *Metoligotoma*, and this has necessitated the preparation of a further systematic paper, both to describe new forms and to modify certain descriptions given in the earlier papers. In particular, a study of series of specimens belonging to the genus *Metoligotoma* from numerous localities has shown which characters possess variations of taxonomic importance, so that it has become necessary to divide into several species those forms previously classed as *M. reducta reducta* Davis.

The specific descriptions have been somewhat modified as a result of experience. The head-breadth has been added to the list of measurements, as being a more reliable factor than head-length, which is influenced by the position of the labrum in each individual when examined. For each measurement (total length, head-length and head-breadth) only the maximum and minimum for the available material is given, the average for the series not being regarded of sufficient significance to merit calculation. The data for the ratio head:thorax:abdomen have also been omitted, as showing too great a divergence in members of any one series, depending on the degree of contraction of the body. The normal number of segments for complete antennae seems to vary; therefore, the numerical limits have been given for what seem to be undamaged antennae, the lower limit based on the occurrence of several individuals with an equal number of segments on both sides and with the terminal segments smoothly rounded. Antennal length is given as a ratio of the head-breadth, not as a maximum absolute length. For each series, the numbers of adult specimens of both sexes examined for taxonomic purposes are given.

In addition to the size limits for both sexes, and a description of the colour of the darkest (i.e. most fully matured) specimens, only the head-outline and terminalia of the males are described. Other characters, such as the mandibles, tergites (except those included in the male terminalia), legs, female terminalia, etc., are of no taxonomic importance specifically in the genus *Metoligotoma*, and are similar to the structures described in the earlier papers of this series.

Details of the colour and size of females have been included, when available, and female allotypes and paratypes have been named. However, no characters have been found whereby the females can be determined specifically, and it seems that in this Order a description based on the male alone is likely to be

as useful as one based on an examination of both sexes. Descriptions based on the female alone are worthless.

The figures in this paper are from camera lucida outlines. Colour descriptions are based on the appearance, under the binocular microscope, of alcoholic material. Living material often appears darker to the naked eye. Measurements were made with a calibrated ocular micrometer, and are exclusive of appendages. Unless otherwise stated, all the localities are in New South Wales, and all material was collected by the author.

Genus METOLIGOTOMA Davis, 1936.

PROC. LINN. SOC. N.S.W., lxi (5), 1936, p. 248.

The original generic description must be slightly modified in the light of additional material, but the genus appears to be a natural one, certain characters peculiar to it being practically unchanged throughout the entire range of its constituent species. The modified description is as follows:

Wingless Oligotomidae, the males possessing the following characters: Left cercus one-segmented, due to the complete fusion of the two larval segments, the resulting structure bearing minute nodules on its inner face; first segment of right cercus reduced to a broad base for the accommodation of the second segment; left hemitergite of tenth abdominal segment produced backwards to a process from its inner margin; right hemitergite with a dorsal foliaceous process projecting inwards in a more or less horizontal plane; hypandrium produced backwards on the right-hand side to a slender, tapered process, between which and the body of the hypandrium lies a subtriangular plate. Both sexes with two minute bladders placed ventrally on the first segment of the hind tarsi, and one bladder on the second segment.

The form of the process of the left hemitergite was formerly described as slender and sinuous; this does not fit all the species. The left cercus-basipodite, originally described as a small free sclerite, is in some cases quite massive, and often largely membraneous. The form of the appendages of the hypandrium has been added to the former description, as being peculiar to the genus as at present constituted, and constant in all its members.

METOLIGOTOMA REDUCTA Davis, 1936. Figs. 1-4.

M. reducta reducta Davis, PROC. LINN. SOC. N.S.W., lxi (5), pp. 248-250 (pars).

Under the above heading I previously included what is now shown to be an assemblage of several different species. The name *M. reducta* must now be confined to those specimens agreeing with the holotype, which was collected at Elanora, near Narrabeen (Map 1, 1A). Specimens from the other localities listed (l.c., p. 250), some of which were at the time designated paratypes, are transferred to other species, as detailed later. In view of the error which has been introduced, the term paratype is restricted in future to specimens from the locality of the holotype exactly agreeing with it in structural detail. As the original description and figures do not conform to the name in the strict sense, a revised description of *M. reducta* is appended.

♂. Length 6·7-11·5 mm.; head, length 1·44-2·37 mm., breadth 1·18-1·92 mm. Length of apparently complete antennae 2·3 to 3·5 times the corresponding head-breadth, with 16-20 segments. *Colour*: Head, including eyes, black; thoracic and abdominal tergites dark brown (almost black), not shiny. Pleurites very dark brown. Sternites dark brown, almost black, except the anterior abdominal sternites, which are somewhat paler medially. Segments of antennae golden-

brown; segments of legs dark brown, with noticeable cream-coloured portions near the joints. Cerci pale golden-brown. Intersegmental membranes (little visible) cream. *Head*: As in all species in which a long series was examined, the largest head-capsules are well-formed, and show specific characters, but the smaller head-capsules retain, to a greater or less extent, the rounded facies of the larval capsule. Although this fact discounts the use of the head-capsule outline as a taxonomic feature, the outline of the largest head-capsules for each species is described and figured. In *M. reducta* (fig. 1) the head is widest at the eyes (as in all species), and the sides run backward to the posterior limits, converging strongly. A marked lump occurs on each side approximately midway between the eyes and the posterior angles, which are obtusely rounded. *Terminalia* (figs. 2, 3, 4): Ninth abdominal tergite (9) shorter than the preceding tergites, slightly asymmetrical. Tenth tergite divided into left and right hemitergites, the right (10R) massive, subtriangular, terminating distally in a rounded process (10RP$_1$) projecting inwards and downwards. 10R with a dorsal process (10RP$_2$), foliaceous, smoothly rounded, projecting to the left and slightly forward in a more or less horizontal plane. Left hemitergite (10L) subtriangular, produced to a slender backwardly-directed process (10LP) from its inner margin. 10LP terminally curving to the left and downwards, ending in a suboval plate, wider than the immediately proximal part of 10LP. Basally, the area between 10L and 10R is occupied by several smaller sclerites. Right cercus normal for the genus, the first segment (RC$_1$) broader than long, fused to the outer side of 10R, and serving as a base for the second segment (RC$_2$), which is subcylindrical. Left cercus (LC) one-segmented, approximately pyriform in dorsal view, with minute teeth on its inner face. Especially in specimens observed soon after the last ecdysis, the former division of the cercus into two segments is clearly indicated as a paler line running obliquely across the fused structure, separating off the outer and distal portion from the remainder, the larval first segment. Ventrally, the hypandrium (H), a large plate, is produced backwards from its right-hand margin to a tapered process (HP$_1$), the space between this and the body of the hypandrium being filled by a subtriangular plate (HP$_2$). Left cercus-basipodite (LCB) bluntly rounded distally, membraneous except along the outer (left) side and at the distal extremity.

Ventral to 10RP$_2$, and arising from 10R, is a broad, tapered process, membraneous laterally, usually projecting downwards and invisible in dorsal view. In other species of this genus its description is omitted, as it is of no systematic importance. It occurs in the males of all species of the genus. In earlier papers it was suggested that this structure might be the aedeagus (see, e.g., Davis, 1936*a*, fig. 10, A; 1936*b*, fig. 4, A), but a closer examination of its origin, position and attachment, and a study of the internal anatomy of the males of the genus, discount this surmise. It is to be regarded as an inferior appendage of 10R.

Thirty-three males of this species from the type locality have been examined in detail.

♀. Since, at the holotype locality, further collecting has shown that two species occur together (as detailed later), it has been impossible to select an allotype female of *M. reducta*. The males of the second species are on the average considerably larger than those of *M. reducta*, and when the head-breadths of a series of females, collected with males of both species in this locality, were graphed against frequency of occurrence, the curve showed two peaks and a trough (frequency not zero) between. It is probable that the smallest of these females belong to

M. reducta. The details of this series (including both species) are as follows: *Colour*: Head very dark brown, eyes black. Thoracic and abdominal tergites dark brown, pronotum with pale golden-brown pattern (cf. Davis, 1936a, fig. 42; this pattern recurs frequently in the Order), other tergites with golden-brown mid-dorsal line and lateral spots. Pleurites dark brown. Sternites ranging from pale brown at centre to dark brown at lateral margins, ninth abdominal sternite dark brown throughout. Segments of antennae, legs and cerci golden-brown, paler near joints. Intersegmental membranes (not much visible) cream. *Dimensions*: Length 8·6–14·6 mm.; head, length 1·63–2·11 mm., breadth 1·22–1·73 mm.; length of apparently complete antennae 2·0–2·4 times the corresponding head-breadth, with 16–20 segments.
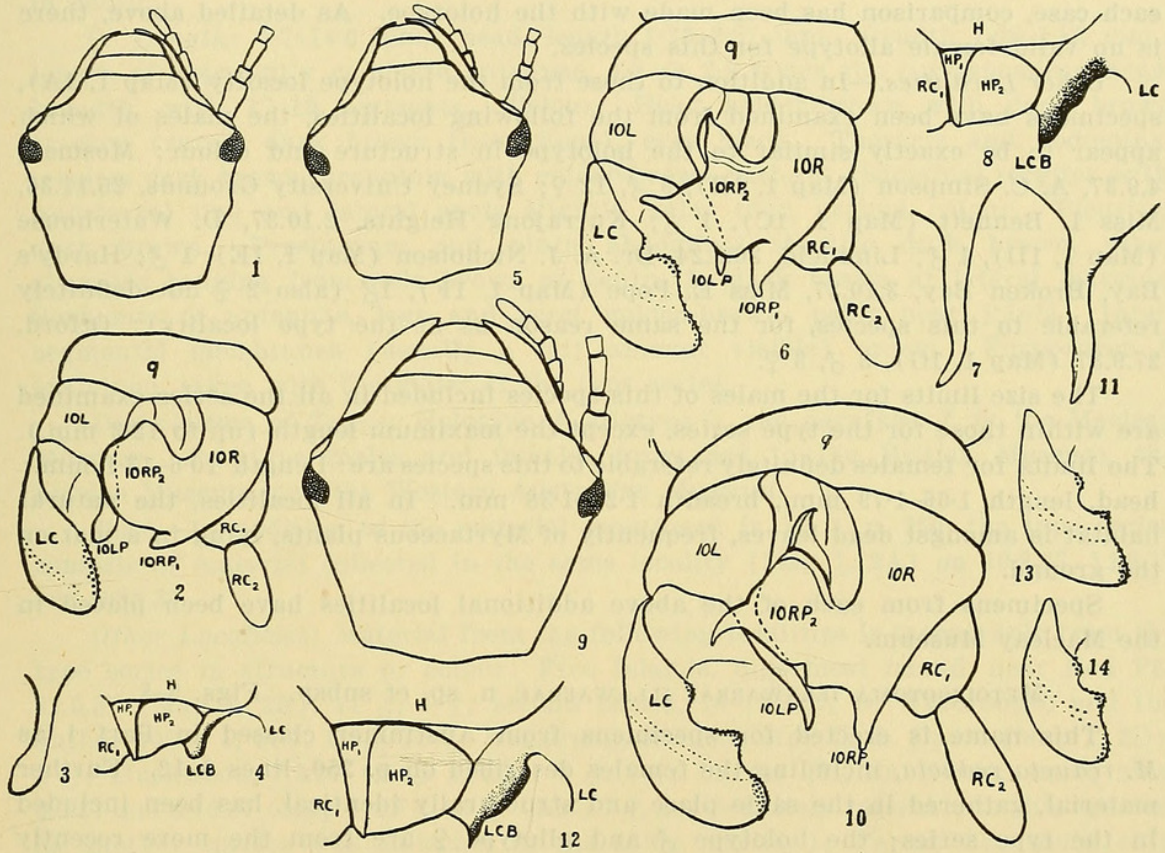
Figs. 1-4.—*Metoligotoma reducta* Davis.—1. Dorsal aspect of well-developed head-capsule, ♂, × 12 ; 2. Dorsal aspect of ♂ terminalia, × 25 ; 3. Ventral aspect of left cercus-basipodite, ♂, stippling to indicate degree of chitinization, adjacent structures indicated in outline to show relations, × 25 ; 4. Process of left hemitergite of tenth abdominal segment viewed from above, with extremity raised to same level as base, × 30.

(9. Ninth abdominal tergite ; 10L, 10R, left and right hemitergites of tenth abdominal segment ; 10LP, process of 10L ; 10RP$_1$, 10RP$_2$, posterior and dorsal processes of 10R ; RC$_1$, RC$_2$, first and second segments of right cercus ; LC, one-segmented left cercus, dotted lines to indicate paler area between first and second segments of previous instar, now fused ; H, hypandrium ; HP$_1$, HP$_2$, right and left appendages of H ; LCB, left cercus-basipodite. All setae omitted.)

Figs. 5-8.—*Metoligotoma illawarrae illawarrae*, n. sp. et subsp., corresponding structures, magnifications and lettering to figs. 1-4.

Figs. 9-12.—*Metoligotoma illawarrae septentrionis*, n. subsp., corresponding structures, magnifications and lettering to figs. 1-4.

Figs. 13-14.—Intermediates between *M. illawarrae illawarrae* and *M. illawarrae septentrionis*, from Jooriland, Burragorang Valley ; ♂ left cercus, × 25.

One of the smallest of this series was selected as probably representing the female of *M. reducta*, and placed in the Macleay Museum, labelled accordingly. The allotype and paratype females named in the former paper were from Jooriland, Burragorang Valley, and are referable to another species, as detailed later.

Distribution of Types: The holotype male, from Elanora, near Narrabeen (16.9.34, M. Day and D. Waterhouse), is in the Macleay Museum. To those of the Museums listed (Davis, 1936a, p. 250) to whom male specimens were sent, as paratype material, which now prove to be referable to other species, I have forwarded correctly identified males (metatypes–topotypes) of *M. reducta*. This material has been collected at the holotype locality, being either from one of the series from this locality previously listed (Part i, p. 250) or collected more recently (24.10.37); in each case, comparison has been made with the holotype. As detailed above, there is no valid female allotype for this species.

Other Localities.—In addition to those from the holotype locality (Map 1, 1A), specimens have been examined from the following localities, the males of which appear to be exactly similar to the holotype in structure and colour: Mosman, 4.9.37, A. C. Simpson (Map 1, 1B), 9 ♂, 12 ♀; Sydney University Grounds, 25.11.36, Miss I. Bennett (Map 1, 1C), 1 ♂; Kurrajong Heights, 2.10.37, D. Waterhouse (Map 1, 1D), 1 ♂; Lindfield, 26.2.24, Dr. A. J. Nicholson (Map 1, 1E), 1 ♂; Hardy's Bay, Broken Bay, 3.10.37, Miss E. Pope (Map 1, 1F), 1♂ (also 2 ♀ not definitely referable to this species, for the same reason as at the type locality); Otford, 27.9.37 (Map 1, 1G), 3 ♂, 3 ♀.

The size limits for the males of this species included in all the series examined are within those for the type series, except the maximum length (up to 12·3 mm.). The limits for females definitely referable to this species are: Length 10·6–13·1 mm.; head, length 1·66–1·79 mm., breadth 1·28–1·38 mm. In all localities, the natural habitat is amongst dead leaves, frequently of Myrtaceous plants, lying in a mat on the ground.

Specimens from each of the above additional localities have been placed in the Macleay Museum.

Metoligotoma illawarrae illawarrae, n. sp. et subsp. Figs. 5–8.

This name is erected for specimens from Austinmer classed in Part i as *M. reducta reducta*, including the females described on p. 250, lines 9–12. Further material, gathered in the same place and structurally identical, has been included in the type series; the holotype ♂ and allotype ♀ are from the more recently collected material.

♂. *Length*: 7·2–11·3 mm.; head, length 1·44–2·21 mm., breadth 1·15–1·89 mm.; length of apparently complete antennae 2·2 to 3·4 times the corresponding head-breadth, with 17–21 segments. *Colour*: Head dark brown, almost black; eyes black. Thoracic tergites very dark brown, abdominal tergites dark golden-brown. Pleurites dark brown, sternites dark golden-brown, prosternum and hypandrium particularly dark. Segments of antennae and legs dark golden-brown, of cerci pale golden-brown, paler near joints. Intersegmental membranes (little visible) cream. *Head* (fig. 5): The head-capsule differs in outline from that of the male of *M. reducta* in that the sides run back practically straight from the eyes to the posterior angles, without any protuberance. The eyes are slightly more prominent. *Terminalia* (figs. 6, 7, 8): Right hemitergite (10R) produced backwards and downwards to a somewhat irregularly-tapered process (10RP$_1$); dorsal process of 10R (10RP$_2$) more irregular than in *M. reducta*, produced from the left-hand (free) end

of its posterior border to a tapered projection; the left-hand (free) end of its anterior border less membraneous than the rest, and produced to a thick, tapered process. Left hemitergite (10L) produced backwards from its inner margin to a slender, tapered process (10LP). Left cercus (LC) with the outer side, as seen from above, rounded, more or less semicircular in outline; inner side, distally, almost straight, minutely toothed, and flattened dorsoventrally. Basad to this straight face, which occupies almost half the length of the cercus, is a marked concavity on the inner side. Left cercus-basipodite (LCB) a small sclerite situated in the membrane between the appendages of the hypandrium and the base of the left cercus; LCB thin, heavily chitinized, ending distally in a small spine. Segments of right cercus (RC_1, RC_2), hypandrium (H) and its appendages (HP_1, HP_2) as in *M. reducta*. Thirty-nine ♂ from the holotype locality examined in detail.

♀. *Length*: 7·7–14·0 mm.; head, length 1·33–2·21 mm., breadth 1·06–1·82 mm.; length of apparently complete antennae, 1·9 to 2·2 times the corresponding head-breadth, with 17–19 segments. *Colour*: Head golden-brown with dark brown tracery (rarely dark brown throughout), eyes black. Thoracic and abdominal tergites dark brown, pronotum with golden-brown pattern, abdominal tergites with mid-dorsal line and lateral spots slightly paler than ground colour. Pleurites dark brown. Prosternum and ninth abdominal sternite dark brown, other sternites ranging from pale brown at centre to dark brown at lateral margins. Segments of antennae, legs and cerci golden-brown, paler near joints. Inter-segmental membranes (usually a fair amount visible) cream. Forty-seven ♀ examined, taken with the males of the type series.

Distribution of Types: Holotype ♂, allotype ♀, and paratype ♂, in the Macleay Museum. Paratype males and females forwarded to the British Museum, the Leyden Museum, and the Western Australian Museum.

Note.—In addition to the material mentioned in Pt. i, p. 250, the type series consists of material collected in the same locality (Map 1, 2A) on 10.8.37, 12.9.37 and 20.9.37.

Other Localities: Material from the following localities is inseparable from the type series in structure or colour: Five Islands, innermost island, near Red Pt., 31.5.37 (Map 1, 2B), 11 ♂, 6 ♀; second island, 18–19.8.37, D. Waterhouse and the author (Map 1, 2C), 11 ♂, 16 ♀; Bamarang, 28.11.36, Mrs. G. L. Davis (Map 1, 2D), 2 ♂; Huskisson, 7.9.37 (Map 1, 2E), 8 ♂, 7 ♀; Parma Ck., nr. Nowra, north side, 6.9.37 and 2.10.37 (Map 1, 2F), 18 ♂. (Also 7 ♀, not definitely referable to this species, as another species was collected in the same locality.); Parma Ck., south side, 8.10.37, Mrs. G. L. Davis (Map 1, 2G), 6 ♂, 4 ♀; Hardy's Bay, Broken Bay, 3.10.37, Miss E. Pope (Map 1, 2H), 3 ♂; Red Pt., Port Kembla, 17.12.37, D. Waterhouse (Map 1, 2J), 1 ♂, 1 ♀; Jooriland, Upper Burragorang, 1.12.37 (Map 1, 2K), for details see page 232.

Size limits for all series examined: ♂, length 7·2–11·9 mm.; head, length 1·25–2·24 mm., breadth 1·06–1·92 mm. ♀, length 7·7–14·0 mm.; head, length 1·28–2·21 mm., breadth 0·99–1·82 mm.

Note.—The normal situation is as for *M. reducta*, but the specimens from the innermost of the Five Islands were amongst the creeping stems of the succulent *Mesembryanthemum aequilaterale*.

Specimens from each of the above localities have been placed in the Macleay Museum.

METOLIGOTOMA ILLAWARRAE SEPTENTRIONIS, n. subsp. Figs. 9–12.

Males collected at Elanora, near Narrabeen, 24.10.37, in association with *M. reducta*, resemble *M. illawarrae illawarrae* in most characters, but constant small differences in the terminalia necessitate the recognition of a separate subspecies. Thirteen ♂ of this series have been examined in detail.

Terminalia (figs. 10, 11, 12): The distal part of the inner face of the left cercus, practically straight in *M. illawarrae illawarrae*, in this subspecies consists of a rounded tooth at the basal limit separated from the more distal portion of the cercus by a marked concavity. Other small differences are present; the process of the left hemitergite ends more sharply, and is somewhat roughened on the left-hand side; the left cercus-basipodite is slightly different in form from that of *M. illawarrae illawarrae* (cf. figs. 8 and 12). Other characters, including the colour, show no differences, except that in the fully-developed head (fig. 9) the eyes are somewhat less prominent. *Dimensions*: Length 9·1–14·1 mm.; head, length 1·92–2·78 mm., breadth 1·57–2·40 mm.; length of apparently complete antennae 2·5 to 3·1 times the corresponding head-breadth, with 18–23 segments. Maximum antennal length observed, 6·1 mm.

Distribution of Types: Holotype ♂ and paratype ♂ in the Macleay Museum; paratype males forwarded to the British Museum, the Leyden Museum, and the Western Australian Museum. I am unable to select an allotype female, but have placed one of the largest females of the series mentioned on p. 228 in the Macleay Museum, labelled accordingly.

The males of the type series of this subspecies, and the males of *M. reducta* collected on the same date, were taken within a radius of a hundred yards, and in some cases males of both types were collected within a radius of one yard. For the type locality, see Map 1, 2′A.

Other Localities: Males from the following locality are not distinguishable from the type series in structure or colour: Yellow Rock, nr. Springwood, 15.10.37 and 28.10.37 (Map 1, 2′B), 3 ♂, 3 ♀. Colour of females as for series described on p. 229, size limits as follows: Length 14·9–17·2 mm.; head, length 2·14–2·30 mm., breadth 1·73–1·82 mm. Size limits for males within those for type series, except maximum length (14·4 mm.). (Both the above, and the type series, are on the average considerably larger than any of the series of *M. illawarrae illawarrae* examined. In both localities, the situation was the same as that detailed for *M. reducta*. Identified specimens from Yellow Rock have been placed in the Macleay Museum. The locality is the same as that mentioned under *M. reducta* in Part i, Springwood, 1.10.34, D. Waterhouse.); Jooriland, Upper Burragorang, 1.12.37 (Map 1, 2′C). (This interesting series seems to represent the intergradation of *M. illawarrae illawarrae* and *M. illawarrae septentrionis*. Of the 24 ♂ examined, 9 could be classed as the former, 5 as the latter, the remaining 10 being intermediate. The left cercus forms the most reliable basis for comparison between the two subspecies. Figures 13 and 14 illustrate the left cerci of intermediate forms from this series. The dimensions of the males of this series are: Length 7·5–12·5 mm.; head, length 1·60–2·50 mm., breadth 1·38–2·11 mm. The typical members of the two subspecies in this series are inseparable on a size basis, the averages approximating to one another.)

In association with the above, 14 ♀ were collected, not assignable to subspecies. In the original description of *M. reducta reducta* (Davis, 1936a,) the allotype and paratype females were selected from material from this locality. In view of the above facts, these specimens now lose all status as type material.

This series has been lodged in the Macleay Museum.

METOLIGOTOMA ILLAWARRAE TELOCERA, n. subsp. Figs. 15–22.

♂. *Length* 9·9–15·0 mm.; head, length 1·89–2·88 mm., breadth 1·47–2·11 mm. Length of apparently complete antennae 2·4 to 3·2 times the corresponding head-breadth, with 20–23 segments. Maximum antennal length observed, 6·1 mm. *Colour*: Head very dark brown, eyes black. Pronotum dark brown with pale-brown pattern, other tergites dark golden-brown with paler mid-dorsal line and lateral flecking. Pleurites dark brown. Prosternum and hypandrium dark brown, other sternites pale brown at centre merging into golden-brown or dark brown at lateral margins. Segments of legs, antennae and cerci golden-brown, paler near joints. Intersegmental membranes (a fair amount visible) cream. *Head* (fig. 15): Similar in general outline to that of *M. illawarrae septentrionis*. *Terminalia* (figs. 16–22): Similar in most respects to those of the former two subspecies, the process of the left hemitergite ending more bluntly, and the posterior process of the right hemitergite (10RP$_1$) shorter and more inwardly directed. The form of the left cercus is the chief subspecific character; it approaches *M. illawarrae septentrionis* more closely than *M. illawarrae illawarrae*, but the tooth basad to the termination on the inner side is less prominent, the termination more tapered, and the distal part of the inner face less markedly flattened dorso-ventrally and relatively shorter. In figures 19–22, as well as in figure 16, is shown the extent of variation of the left cercus in specimens from the type locality. There is, especially in figures 21 and 22, an approach to the type found in *M. illawarrae septentrionis*, but all specimens examined differ from this type. Eleven ♂ examined in detail.

♀. *Length* 12·2–18·1 mm.; head, length 1·89–2·08 mm., breadth 1·50–1·63 mm. Length of apparently complete antennae 2·0 to 2·3 times the corresponding head-breadth, with 20–23 segments. *Colour*: Head golden-brown with dark-brown tracery, eyes black. Thoracic and abdominal tergites, pleurites, and segments of antennae, legs and cerci, as in the ♂. Sternites as in the male, the eighth abdominal dark except at the centre, the ninth dark throughout. Intersegmental membranes (much visible) cream. Nine ♀ examined in detail.

Locality: Cooper Park, Bellevue Hill (Sydney) (Map 1, 2″A), 15.9.37 and 26.9.37, amongst a mat of dead leaves of *Leptospermum*. This is practically the only locality in this district which has been left in a state sufficiently close to the original to harbour these insects.

Distribution of types: As for *M. illawarrae illawarrae.*

METOLIGOTOMA COLLINA COLLINA, n. sp. et subsp. Figs. 23–26.

♂. *Length* 9·9–13·2 mm.; head, length 2·34–2·59 mm., breadth 2·02–2·24 mm. Length of apparently complete antennae 1·6–2·0 times the corresponding head-breadth, with 17–19 segments. *Colour*: Head black, shiny, eyes black; thoracic and abdominal tergites very dark brown, pronotum with pale-brown pattern, metascutum and abdominal tergites with pale mid-dorsal line and lateral flecking. Pleurites dark brown. Sternites pale brown at centre, merging to dark brown at lateral margins, anterior abdominal sternites with greater proportion pale than the rest, hypandrium dark golden-brown throughout. Segments of antennae, legs and cerci dark golden-brown, paler near joints, paler areas on femora. Intersegmental membranes (little visible) cream. *Head* (fig. 23): Eyes not prominent. Sides of the head running back practically straight from the eyes, and converging strongly. *Terminalia* (figs. 24–26): Right cercus, hypandrium and its appendages, normal for the genus. Right hemitergite (10R) with its posterior process (10RP$_1$) slender and pointed, directed inwards and slightly curved; dorsal process of 10R (10RP$_2$) with its left-hand edge sinuate, its anterior margin with a tapered process

directed forward; left-hand part of 10RP$_2$ especially membraneous. Left hemi-
tergite (10L) with its process (10LP) directed backwards and downwards, curving
to the left distally, termination tapered, acute; a flat obtuse projection is present
basad to the termination, directed to the left and upwards. Left cercus (LC)
curving inwards distally, with a concavity basad to the termination on the inner
face, and then a rounded tooth, with minute nodules, such as are also present
on the inner side of the terminal part of the cercus. Left cercus-basipodite (LCB)
massive and obtuse, membraneous except distally and on the outer (left-hand)
margin. Five ♂ from the holotype locality examined in detail.
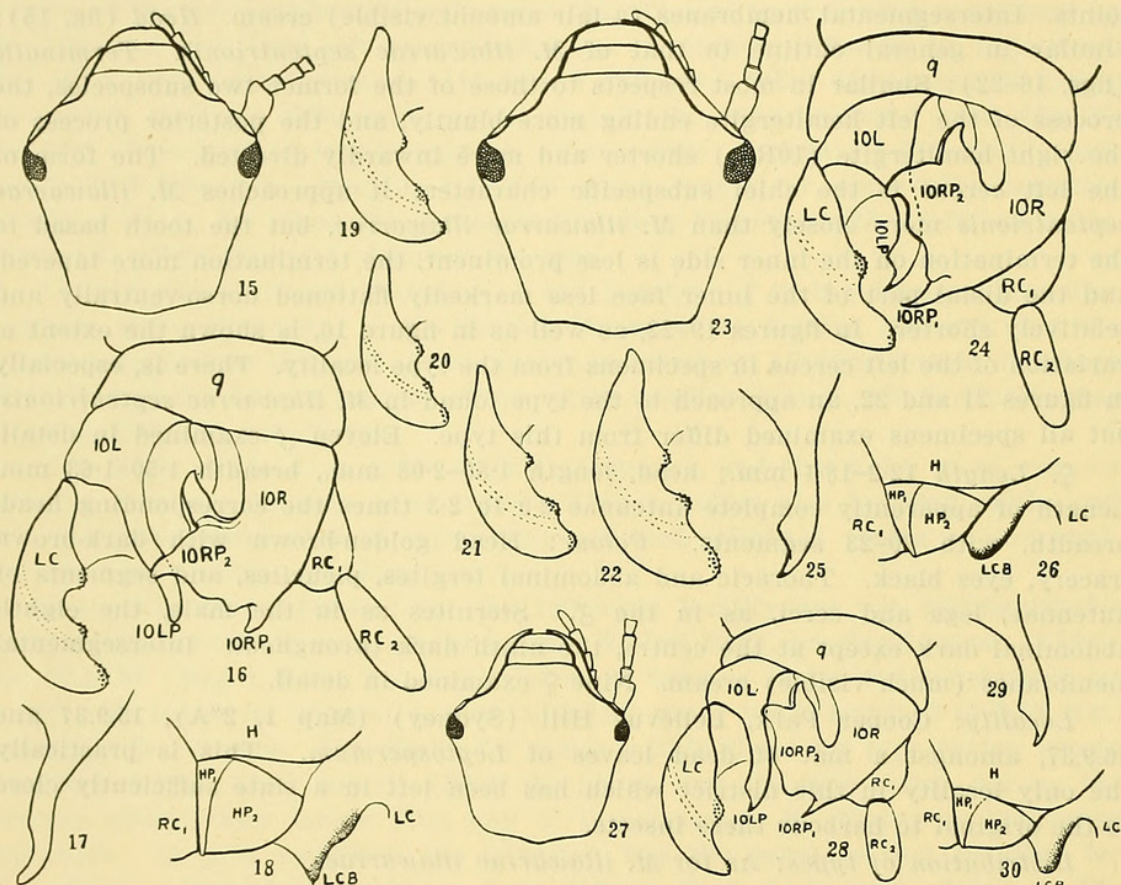
Figs. 15-22.—*Metoligotoma illawarrae telocera*, n. subsp. Figs. 15-18, corresponding
structures, magnifications and lettering to figs. 1-4. Figs. 19-22, variations of ♂ left
cercus, × 25.
    Figs. 23-26.—*Metoligotoma collina collina*, n. sp. et subsp., corresponding structures,
magnifications and lettering to figs. 1-4.
    Figs. 27-30.—*Metoligotoma collina exigua*, n. subsp., corresponding structures, magni-
fications and lettering to figs. 1-4.

    ♀. *Length* 10·0-12·3 mm.; head, length 1·63-1·95 mm., breadth 1·28-1·57 mm.
Length of apparently complete antennae 1·8-2·2 times the corresponding head-
breadth, with 15-18 segments. *Colour*: Head dark brown with golden-brown
pattern, eyes black. Other structures as in the ♂, more of the intersegmental
membranes visible, ninth abdominal sternite dark throughout, eighth dark except
at the centre. Seventeen ♀ from the type locality examined.

    Type Locality: Razorback, nr. Picton (Map 1, 3A), 18.9.37 and 27.9.37, amongst
fallen leaves.
    Distribution of Types: As for *M. illawarrae illawarrae*.

Other Localities: Specimens from the slopes of The Gib, between Mittagong and Bowral (Map 1, 3B; coll. 18.9.37 and 27.9.37) agree with the type series in structure and colour, and are of the following dimensions: ♂ (5 specimens examined in detail), length 10·0–11·6 mm.; head, length 1·86–2·27 mm., breadth 1·50–1·88 mm.; ♀ (8 specimens examined), length 11·0–13·3 mm.; head, length 1·60–2·08 mm., breadth 1·34–1·63 mm. Identified specimens of each sex from this series placed in the Macleay Museum. *Note.*—This locality is the same as that listed in Part i, p. 250, under *M. reducta reducta* (Mittagong, D. Lee, 30.7.35).

METOLIGOTOMA COLLINA EXIGUA, n. subsp. Figs. 27–30.

♂. *Length* 8·3–10·4 mm.; head, length 1·41–2·02 mm., breadth 1·18–1·60 mm. Length of apparently complete antennae 2·1–2·5 times the corresponding head-breadth, with 16–18 segments. *Colour*: As in the ♂ of *M. collina collina*, but somewhat paler throughout. *Head* (fig. 27): As in *M. collina collina*, the eyes a little more prominent, the sides converging less strongly. *Terminalia* (figs. 28–30): Similar in general form to *M. collina collina*, the basal part of the process of the left hemitergite (10LP) somewhat more contorted, curving down more sharply to form a hollow into which fits the basal part of the in-drawn left cercus; the subterminal flat expansion of 10LP not as broad as in *M. collina collina*; the terminal portion of the left cercus (LC) more slenderly tapered; and the processes of the right hemitergite slightly different in form.

Fifteen ♂ examined in detail.

♀. *Length* 10·1–11·0 mm.; head, length 1·47–1·60 mm., breadth 1·15–1·22 mm. Length of apparently complete antennae 1·9 times the corresponding head-breadth, with 15–16 segments. Both sexes noticeably smaller than *M. collina collina*, especially the head capsules. *Colour*: As in the ♀ of *M. collina collina*, but somewhat paler throughout. Four ♀ examined.

Locality: Wentworth Falls (Map 1, 3′A), 15.10.37, amongst fallen leaves.

Distribution of Types: As for *M. illawarrae illawarrae*.

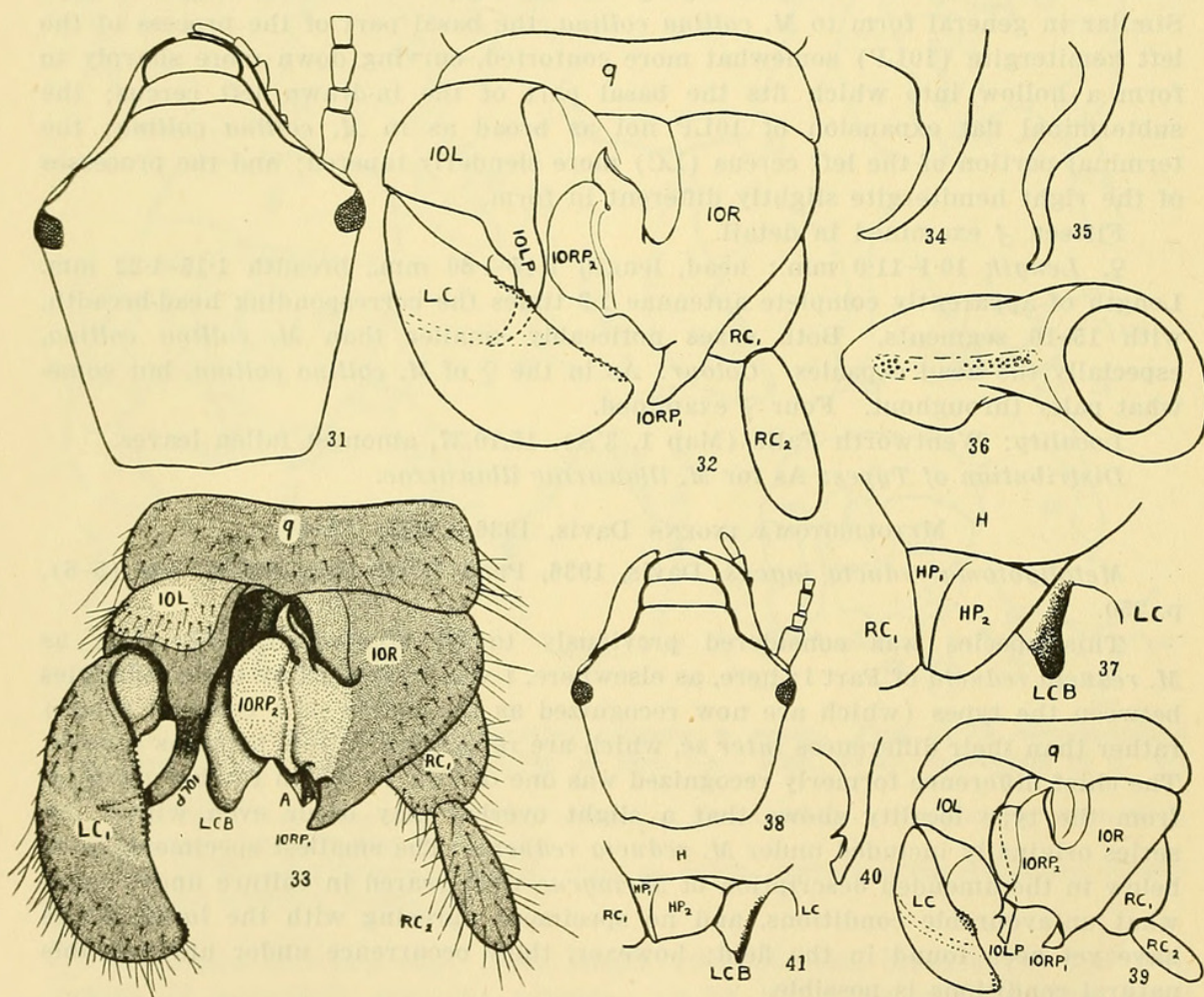### METOLIGOTOMA INGENS Davis, 1936. Figs. 31–37.

Metoligotoma reducta ingens, Davis, 1936, PROC. LINN. SOC. N.S.W., lxi (5–6), p. 250.

This species was considered previously to be structurally the same as *M. reducta reducta* of Part i; here, as elsewhere, I was impressed by the similarities between the types (which are now recognized as the marks of a compact genus) rather than their differences *inter se*, which are recognized in this paper as specific. The chief difference formerly recognized was one of size, in which further material from the type locality shows that a slight overlap may occur even within the series originally included under *M. reducta reducta*. The smallest specimens listed below in the amended description of *M. ingens* were reared in culture under somewhat unfavourable conditions, and no specimens agreeing with the lower limits have yet been found in the field; however, their occurrence under unfavourable natural conditions is possible.

The revised description is based on re-examination of available specimens of the original type-series, and on metatypes (topotypes) collected more recently from the colony from which the original series was taken. No structural variation was noticed within the complete series.

♂. *Length* 8·4–14·2 mm.; head, length 1·96–3·65 mm., breadth 1·57–2·76 mm.; length of apparently complete antennae 2·2 to 2·6 times the corresponding head-breadth, with 16–19 segments. *Colour*: See Davis, 1936a, pp. 250–251. *Head*

(fig. 31): Eyes not prominent; sides of the head behind the eyes straight, not converging as markedly as in the previous species. *Terminalia* (figs. 30–36): Segments of right cercus (RC_1, RC_2), hypandrium (H) and its appendages (HP_1, HP_2) normal for the genus. Right hemitergite (10R) with its posterior process ($10RP_1$) directed inwards and downwards, tapered but not acutely so. Dorsal process of 10R ($10RP_2$) with its left-hand portion membraneous, semi-circular, and with a thicker anterior projection on the left-hand (free) side. Left hemitergite (10L) with its process (10LP) slender, tapered, ending sharply, greatly contorted, distally fitting into the under-side of the left cercus. Left cercus (LC) more or less semicircular in dorsal view, but in side view having a marked ventral concavity for the accommodation of the distal part of 10LP. Left cercus-basipodite (LCB) massive, obtuse, membraneous except along its distal and outer borders. Seventeen ♂ examined.

Figs. 31-37.—*Metoligotoma ingens*, n. sp. Figs. 31, 32, 34 and 37, corresponding structures, magnifications and lettering to figs. 1-4; Fig. 33, as fig. 32, stippling to show degree of chitinization, and overlap; all species are referable to the line drawings in the same way as this is comparable to fig. 32. A, inferior appendage of 10R (N.B.—Fig. 33 is freehand, not based on camera lucida outlines). Fig. 35: as fig. 34 but viewed laterally (from the left). Fig. 36, left cercus (LC of fig. 32) detached and viewed laterally (from the right); distal end to the left. × 25.

Figs. 38-41.—*Metoligotoma pentanesiana* Davis, corresponding structures, magnifications and lettering to figs. 1-4. (From the holotype).

♀. *Length* 13·6–19·2 mm.; head, length 2·13–2·67 mm., breadth 1·60–2·15 mm. Length of apparently complete antennae 1·8–2·1 times the corresponding head-breadth, with 16–19 segments. *Note.*—This species is the largest member of the family, and rivals in size the largest member of the Order (*Embia major* Imms), the maximum recorded length for which is 20·75 mm. *Colour*: See Davis, 1936a, p. 251. More of the intersegmental membranes visible than in the ♂.

Locality: This species is recorded only from the original locality, Black Mountain, Canberra, F.C.T. (Map 1, 4A), where it is present in large numbers.

Distribution of Types: The labels of the original types have been .amended to indicate specific rank. Metatype males have been forwarded to the British Museum and the Leyden Museum.

METOLIGOTOMA PENTANESIANA Davis, 1936. Figs. 38–41.

PROC. LINN. SOC. N.S.W., lxi (5–6), pp. 254–256.

This species has been refigured from the holotype, from the same aspects as for the other species in this paper; this is especially important in figure 40, as in the earlier figure the natural downward flexure of the process of the left hemitergite obscured details of its terminal portion.

In addition to the type locality (most northerly of the Five Islands; Map 1, 5A), specimens have been secured (coll. 19.9.37, matured 12–30.10.37) at the top of the Macquarie Pass, near Robertson (Map 1, 5B). Additional measurements for the type series are: ♂, head-breadth 1·20–1·76 mm.; complete antennal length 2·5 times the corresponding head-breadth; ♀, head-breadth 1·24–1·56 mm.; complete antennal length 1·7–1·9 times the corresponding head-breadth.

The Robertson series agrees with the type series exactly in colour and structure, and falls within its size limits, with the exception of the total lengths of the largest specimens (♂, 10·0 mm.; ♀, 10·9 mm.). The series was collected amongst wood at the base of a dead stump, an unusual situation for this genus. Identified specimens of each sex from this series placed in the Macleay Museum.

This species has been taken only at the above two localities, search at adjacent places (Lighthouse Point, Wollongong; others of the Five Islands; Windang Island; localities on the Macquarie Pass) being unrewarded. It is probably a species which possessed a wider distribution formerly than at present, and has been displaced in most places by *M. illawarrae illawarrae*.

METOLIGOTOMA EXTORRIS Davis, 1936. Figs. 42–66.

PROC. LINN. SOC. N.S.W., lxi (5–6), pp. 256-257.

A long series (114 ♂, and a smaller number of females) obtained from the type locality (Brush Island, Map 1, 6A; coll. 5.9.37, some mature, others maturing subsequently in culture) has made possible the study of individual variation, which in this species is exceptionally marked. The revised description for specimens from the type locality is as follows:

♂. *Length* 8·6–14·1 mm.; head, length 1·60–2·77 mm., breadth 1·28–2·19 mm. Length of apparently complete antennae 1·6–2·3 times the corresponding head-breadth, with 15–21 segments. *Colour*: As in original description. *Head*: Figure 42 is a camera lucida outline of the head of the holotype ♂. *Terminalia*: A considerable amount of individual variation is seen in the left cercus, particularly in the thickness, taper and flexure of the terminal part, and in the prominence of the tooth half-way along the inner face. The range of variation in specimens from the type locality is illustrated (figs. 46–57). The other characters in the terminalia are remarkably constant, as in figures 43–45 (drawn from the holotype).

♀. *Length* 9·3–15·0 mm.; head, length 1·66–2·12 mm., breadth 1·31–1·60 mm. Length of apparently complete antennae 1·6–2·0 times the corresponding head-breadth, with 15–19 segments. *Colour*: See original description.

Distribution of Types: In addition to the types previously distributed (as listed in Part ii), a metatype ♂ (topotype) has been forwarded to the Leyden Museum. A series of males, also metatypes (topotypes), to show the range of structural variation, has been placed in the Macleay Museum.

Other Localities: Ulladulla (Map 1, 6B), —.8.37, Mrs. G. L. Davis (5 ♂), 5.9.37 (15 ♂, 15 ♀). Colour as for the respective sexes from Brush Id.; male terminalia agreeing with the Brush Id. series, but with the left cercus in general showing greater terminal curvature and more prominence of the inner tooth (figs. 58–62).— Hills west of Lake George (Map 1, 6C), coll. 3.6.37, matured 13.9.37, 5 ♂, 10 ♀. Male terminalia agreeing closely with the Ulladulla series, but with the thickening of the process of the left hemitergite more terminally placed than usual in the males from other localities (fig. 63). In one specimen, the left cercus is abnormal (fig. 64), partly retaining the larviform two-segmented nature; this is almost certainly due to injury at or before the final ecdysis.—North of Clyde River at Bateman's Bay (Map 1, 6D), coll. 4.9.37 and 5.10.37, matured 5.10.37–4.11.37, 24 ♂; also a number of females, not definitely separable from the females of another species (described below) occurring in association with them. Male terminalia as for the Brush Id. series, except that the left cercus in most cases is less slenderly tapered terminally (e.g. fig. 65). The terminal portion of the process of the left hemitergite is slightly variable.—Deep Creek, near Mogo (Map 1, 6E), coll.
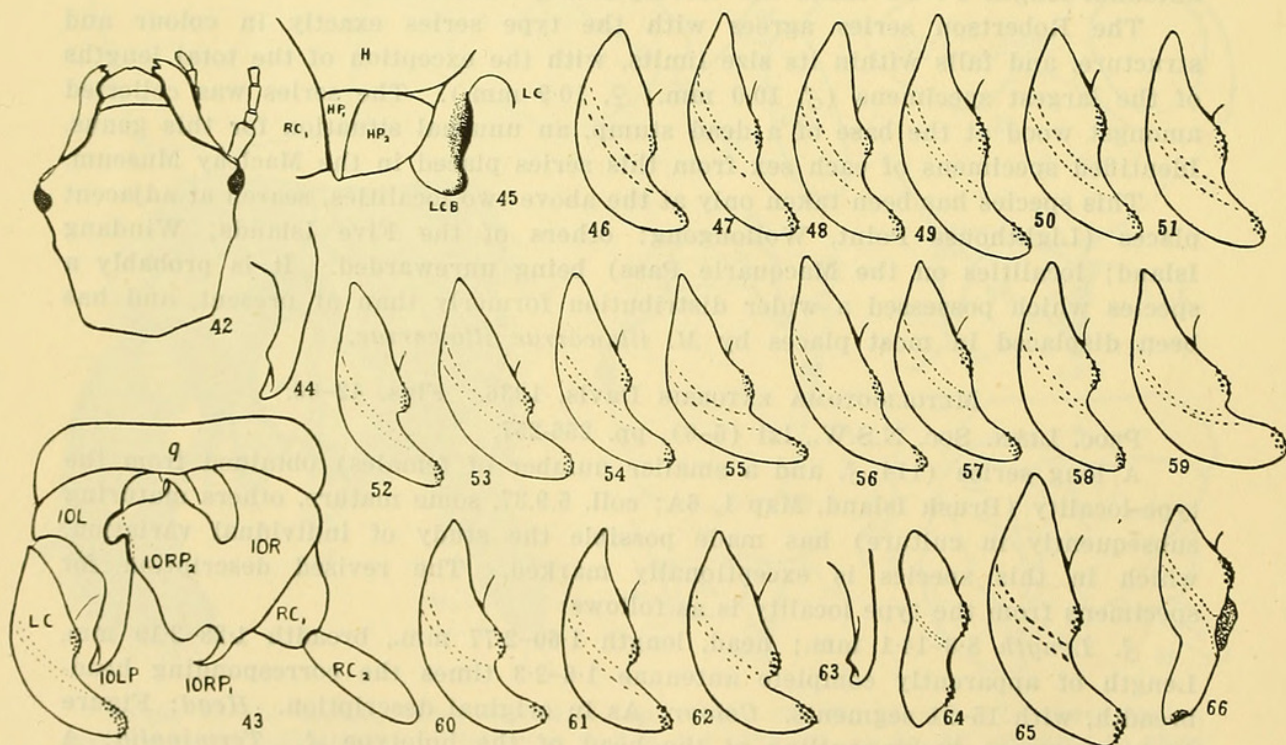
Figs. 42-66.—*Metoligotoma extorris* Davis. Figs. 42-45, corresponding structures, magnifications and lettering to figs. 1-4. (From the holotype). Figs. 46-57, range of variations in the ♂ left cercus in specimens from the type locality (Brush Island), × 25. Figs. 58-62, range of variations in the ♂ left cercus in specimens from Ulladulla, × 25. Fig. 63, as fig. 44, but for Lake George specimen. Figs. 64 and 66, abnormal development of the ♂ left cercus, in individuals from Lake George and Gundary respectively, × 25. Fig. 65, usual form of ♂ left cercus for specimens from Bateman's Bay, × 25.

28.3.37, 4.9.37 and 5.10.37, matured 29.10.37 et seq., 3 ♂, 3 ♀. Male terminalia with the left cerci approaching the Ulladulla series more nearly than the Brush Id. series.—Granite Quarry, north of Moruya River (Map 1, 6E), coll. 9.10.37, matured 29.10.37 et seq., 4 ♂, 5 ♀. Male terminalia with the left cerci as in figures 48 and 57 (Brush Id. series) and figure 61 (Ulladulla series).—Gundary, nr. Moruya (Map 1, 6G), coll. 4.9.37, matured 12.10.37, 1 ♂, terminalia characteristic of this species except the left cercus (fig. 66), which is malformed in a similar way to that illustrated in figure 64.—South of Moruya River, between Moruya and Moruya Heads (Map 1, 6H), coll. 5.10.37, matured 30.10.37, 5 ♂, 8 ♀. Male terminalia with left cerci of the types illustrated in figures 51, 59 and 65; subterminal expansion of process of left hemitergite somewhat broader than usual.—South of Moruya River, nr. Moruya Heads (Map 1, 6J), 9.10.37, 13 ♂, 7 ♀. Male terminalia showing a similar range of variation to the Brush Id. series.

Representative series from each of these additional localities have been deposited in the Macleay Museum.

Size limits for all series examined: ♂, length 8·6–15·2 mm.; head, length 1·60–3·30 mm., breadth 1·28–2·50 mm.; ♀, length 9·3–16·4 mm.; head, length 1·60–2·40 mm., breadth 1·31–1·89 mm.

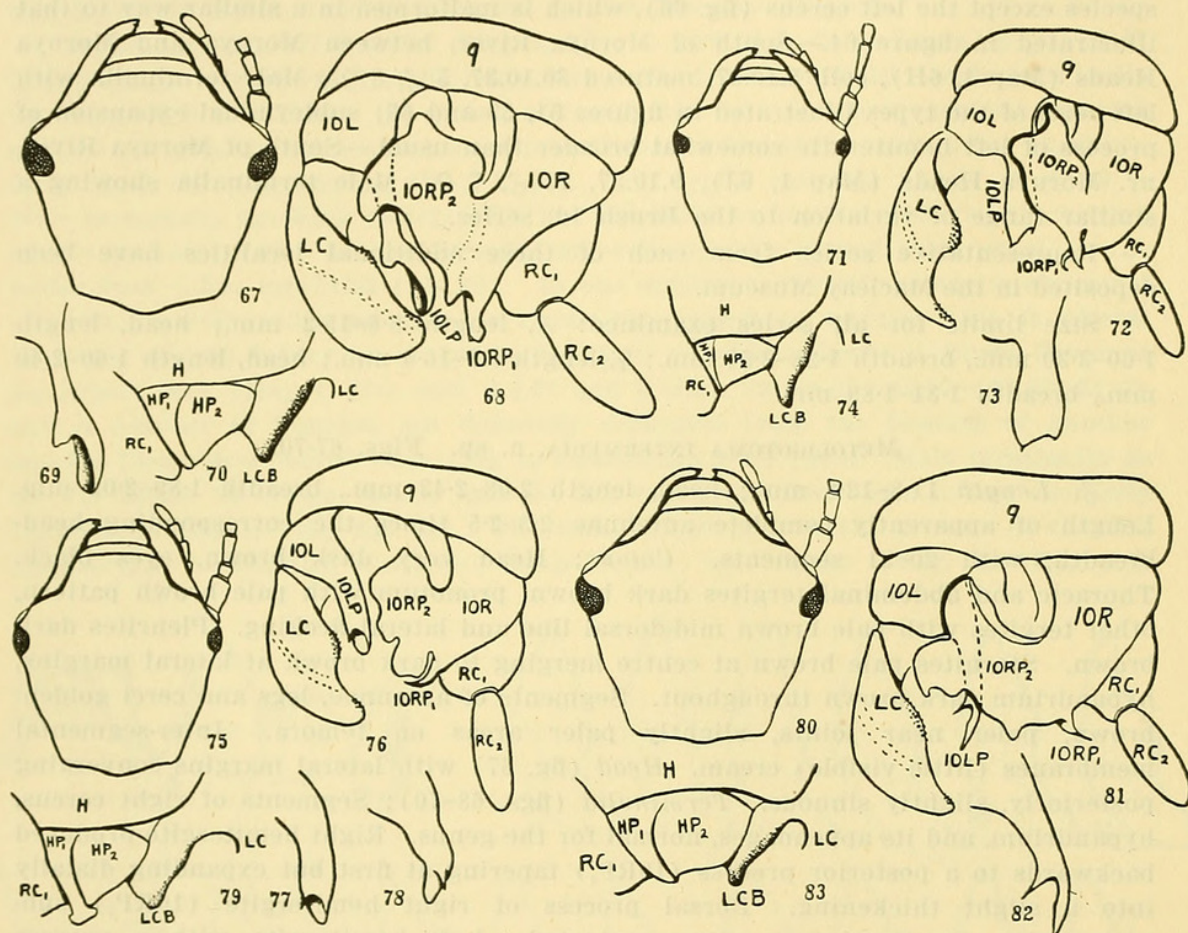## METOLIGOTOMA INTERMEDIA, n. sp. Figs. 67-70.

♂. *Length* 11·8–12·6 mm.; head, length 2·08–2·43 mm., breadth 1·89–2·02 mm. Length of apparently complete antennae 2·3–2·5 times the corresponding head-breadth, with 20–21 segments. *Colour*: Head very dark brown, eyes black. Thoracic and abdominal tergites dark brown, pronotum with pale brown pattern, other tergites with pale brown mid-dorsal line and lateral flecking. Pleurites dark brown. Sternites pale brown at centre merging to dark brown at lateral margins, hypandrium dark brown throughout. Segments of antennae, legs and cerci golden-brown, paler near joints, slightly paler areas on femora. Inter-segmental membranes (little visible) cream. *Head* (fig. 67) with lateral margins converging posteriorly, slightly sinuous. *Terminalia* (figs. 68–70): Segments of right cercus, hypandrium, and its appendages, normal for the genus. Right hemitergite produced backwards to a posterior process ($10RP_1$) tapering at first but expanding distally into a slight thickening. Dorsal process of right hemitergite ($10RP_2$) sub-rectangular, its three free edges contorted. Left hemitergite with a process ($10LP$) of very typical shape, terminating in an ovoid spoon-shaped structure, the concave side facing to the left, with a blunt process basad to this concavity directed backwards and to the left. The process and concavity accommodate the indrawn left cercus (LC), which is massive and smoothly rounded distally, the inner face having a very slight concavity and basad to it a nodulose swelling, not at all prominent. Left cercus-basipodite (LCB) subconical, membraneous except along its outer margin. Three ♂ from the type locality examined in detail.

♀. *Length* 13·3–13·9 mm.; head, length 1·89–1·98 mm., breadth 1·57–1·63 mm.; length of apparently complete antenna 1·9–2·0 times the corresponding head-breadth, with 19 segments. *Colour*: As in the male, but with golden-brown areas on the head; ninth abdominal sternite dark brown throughout, eighth markedly paler. Two ♀ from the type locality examined.

Type Locality: Tomerong, near Nowra (Map 1, 7A), 6.9.37, amongst fallen *Eucalyptus* leaves.

Distribution of types: Holotype ♂, allotype ♀ and paratype ♂ in the Macleay Museum. Paratype ♂ and ♀ forwarded to the British Museum.

Other localities: Males from the following localities agree with the type series in colour and structure: North of Parma Creek, near Nowra (Map 1, 7B), 6.9.37 and 2.10.37, 4 ♂, in association with *M. illawarrae illawarrae*. Certain females in this mixed series were obviously to be correlated with the males of *M. intermedia*, on account of their greater size, but it was impossible to separate the entire series

Figs. 67-70.—*Metoligotoma intermedia*, n. sp., corresponding structures, magnifications and lettering to figs. 1-4.

Figs. 71-74.—*Metoligotoma anomala*, n. sp., corresponding structures, magnifications and lettering to figs. 1-4.

Figs. 75-79.—*Metoligotoma brevispina*, n. sp. Figs. 75-77, 79, corresponding structures, magnifications and lettering to figs. 1-4. Fig. 78, as fig. 77, but viewed laterally (from the left).

Figs. 80-83.—*Metoligotoma convergens*, n. sp., corresponding structures, magnifications and lettering to figs. 1-4.

of females into the respective species. Whereas only 4 ♂ of *M. intermedia* were collected, 18 ♂ of *M. illawarrae illawarrae* were taken at the same time in this locality. Males of *M. intermedia* from this series forwarded to the Western Australian Museum and the Leyden Museum.—Sassafras (Map 1, 7C), 4.10.37 and 10.10.37, 1 ♂, 3 ♀.

Males from these additional localities lodged in the Macleay Museum.

Size limits of all series examined: ♂, length 11·8–13·6 mm.; head, length 2·08–2·91 mm., breadth 1·70–2·43 mm. ♀, within limits of type series.

METOLIGOTOMA ANOMALA, n. sp. Figs. 71–74.

♂. *Length* 7·5–11·0 mm.; head, length 1·28–2·21 mm., breadth 0·96–1·82 mm. Length of apparently complete antennae 1·8–2·3 times the corresponding head-breadth, with 17–19 segments. *Colour*: Head very dark brown (almost black), eyes black. Thoracic and abdominal tergites very dark brown, golden-brown pattern on pronotum, lateral spots and discontinuous mid-dorsal line on other tergites; pleurites dark brown. Sternites ranging from golden-brown at centre to dark brown at lateral margins, prosternum and hypandrium dark throughout. Segments of legs dark brown, of antennae and cerci dark golden-brown, paler near joints. Intersegmental membranes (little visible) cream. *Head* (fig. 71): Sides sinuous, not converging as markedly as in the majority of species. *Terminalia* (figs. 72–74): This is the most divergent of all species studied in the form of the terminalia. Posterior process of right hemitergite (10RP₁) at first directed inwards, then curving backwards and to the right as a slender sickle-shaped process. Dorsal process of right hemitergite (10RP₂) giving off a tapered lobe from its posterior margin near the point of attachment to the hemitergite; this lobe, directed backwards and to the right, overlies 10RP₁. Left hemitergite with a very distinctive subrectangular process (10LP), broad and flat, ending in two sharp points, one at the posterior limit of each side; 10LP not quite dorsoventral, the left-hand side being higher than the right. The distal edge is concave, for the accommodation of the indrawn left cercus. Left cercus (LC) very typical, crescent-shaped, with a rounded nodule-bearing lobe on the concave side midway from base to extremity. Left cercus-basipodite slender, subconical, membraneous except along the outer margin. Twenty ♂ examined.

Locality: North of Clyde River at Bateman's Bay (Map 1, 8A), coll. 4.9.37 and 5.10.37, matured 5.10.37–4.11.37; amongst moss and dead leaves.

These males were in close association with individuals of *M. extorris*. In view of their much smaller size, and the fact that the females collected at the same time fell into two size-groups with few intermediates, it is reasonably certain that the smallest of these females belong to *M. anomala*. The colour of these small females agrees with that of the males of *M. anomala* except that the head possesses paler areas.

Distribution of Types: Holotype ♂ and paratype ♂ in the Macleay Museum; paratype males forwarded to the British Museum, the Leyden Museum and the Western Australian Museum. One of the smallest females deposited in the Macleay Museum, but not recognized as allotype.

METOLIGOTOMA BREVISPINA, n. sp. Figs. 75–79.

♂. *Length* 8·0–11·0 mm.; head, length 1·60–2·24 mm., breadth 1·28–1·82 mm. Length of apparently complete antennae 1·8–2·4 times the corresponding head-breadth, with 16–20 segments. *Colour*: Head very dark brown, eyes black. Thoracic and abdominal tergites very dark brown, the latter with a tendency to golden-brown lateral spots and discontinuous mid-dorsal line. Pleurites dark brown. Prosternum and hypandrium very dark brown, other sternites ranging from pale brown at centre to dark brown at lateral margins. Segments of antennae, legs and cerci dark brown, paler near joints. Intersegmental membranes (little visible) cream. *Head* (fig. 75) with the sides converging slightly posteriorly, and slightly sinuous. *Terminalia* (figs. 76–79): Right cercus and hypandrium normal for the genus; right-hand process of hypandrium (HP₁) unusual in that, instead of tapering terminally, it expands to a small free spathulate tip. Posterior process of right hemitergite (10RP₁) slenderly falciform, curving inwards as in

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M. extorris. Dorsal process of right hemitergite (10RP₂) projecting forwards and to the left, and giving off a posterior lobe near its attachment to the hemitergite. Left hemitergite (10L) small, its process (10LP) rather broad, ending in a rounded and flattened tip and bearing subterminally a short dorsal spine directed backwards and slightly to the left (figs. 77–78). Left cercus-basipodite (LCB) subconical, almost entirely membraneous. Fourteen ♂ from the type locality examined.

♀. *Length* 9·0–13·3 mm.; head, length 1·38–1·86 mm., breadth 1·06–1·44 mm. Length of apparently complete antennae 1·8–2·0 times the corresponding headbreadth, with 15–17 segments. *Colour*: As in the ♂, but the head and pronotum with paler golden-brown areas; the sternites a little paler (the ninth abdominal dark brown); the segments of antennae, legs and cerci dark golden-brown, paler near joints; and more intersegmental membrane visible. Twenty-three ♀ from the type locality examined.

Type Locality: South Bermagui (Map 1, 9A), 3.9.37 and 7.10.37, some mature, others maturing up to 4.11.37; collected amongst dead leaves.

Distribution of Types: As for *M. illawarrae illawarrae*.

Other Localities: Specimens from the following localities agree with the type series in structure and colour: Montague Island (Map 1, 9B), 3.9.37, 13 ♂, 17 ♀; south of Wagonga River at Narooma (Map 1, 9C), 6.10.37, 6 ♂, 5 ♀; north of Wagonga River at Narooma (Map 1, 9D), 6.10.37, 7 ♂, 5 ♀; slopes of the Little Dromedary, Central Tilba (Map 1, 9E), 6.10.37, 2 ♂. As another species (described later) was taken in the same situation, the females from this last locality could not be determined specifically. Identified specimens from each of these additional localities deposited in the Macleay Museum.

Size limits for all series examined: ♂, length 8·0–11·9 mm.; head, length 1·60–2·50 mm., breadth 1·28–2·08 mm. ♀, as for the type series, except maximum length (13·4 mm.).

METOLIGOTOMA CONVERGENS, n. sp. Figs. 80–83.

♂. *Length* 11·5 mm. (unique); head, length 2·40 mm.; breadth 1·82 mm. Number of antennal segments, 20; antennal length 2·1 times the head-breadth. *Colour*: Head very dark brown with golden-brown areas, eyes black. Tergites of thorax and abdomen dark brown, pronotum with golden-brown pattern, other tergites with pale lateral flecking and mid-dorsal line. Pleurites dark brown. Sternites merging from cream at centre to dark brown at lateral margins, hypandrium and prosternum dark throughout. Segments of antennae, legs and cerci golden-brown, paler near joints, the femora with paler areas. Intersegmental membranes (little visible) cream. *Head* (fig. 80): Sides converging very markedly posteriorly. *Terminalia* (figs. 81–83): Right cercus, hypandrium and its appendages normal. Posterior process of right hemitergite (10RP₁) a slender spine directed to the right. Dorsal process of right hemitergite (10RP₂) directed forwards and to the left, its free edges crenulate. Left hemitergite with a very typical process (10LP), slender and tapered, with a prominent spine, directed to the left, arising a little past midway between the origin of the process and its extremity. This process is convergent to its homologue in *M. pentanesiana*, but differs in that the portion distad to the spine is longer and thinner. Left cercus (LC) with its extremity smoothly tapered and slightly incurved; a slight nodule-bearing swelling occurs midway along the inner margin of the cercus. Left cercus-basipodite papillose in shape and fairly heavily chitinized.

♀. *Length* 12·6 mm. (unique); head, length 1·76 mm.; breadth 1·41 mm. Number of antennal segments 18; antennal length 2·0 times the head-breadth.

Colour: As in the ♀ of the preceding species, but paler throughout, and with a considerable amount of pale, cream-coloured membrane visible between all sclerites of the body.

Locality: Tilba Tilba (Map 1, 10A), 30.3.37. A single example of each sex was collected in a nest of web in the bark of a Eucalypt some four feet from the ground, a unique situation for this genus.

Distribution of Types: Holotype ♂ and allotype ♀ in the Macleay Museum.

METOLIGOTOMA BIDENS, n. sp. Figs. 84–89.

♂. *Length* 9·2–12·5 mm.; head, length 1·73–2·56 mm., breadth 1·34–2·05 mm. Length of apparently complete antennae 1·9–2·4 times the corresponding head-breadth, with 19–20 segments. *Colour*: Dorsally very dark brown with golden-brown areas on head and pronotum, and lateral flecking and mid-dorsal line on metascutum and abdominal tergites; eyes black. Pleurites dark brown. Sternites golden-brown, merging to dark brown at lateral margins, hypandrium dark brown throughout. Segments of antennae, legs and cerci golden-brown, paler near joints. Intersegmental membranes (little visible) cream. *Head* (fig. 84): Eyes relatively small; sides of the head almost straight behind the eyes, and converging less markedly than in most species. *Terminalia* (figs. 85–88): Right cercus normal; hypandrium with its right-hand process (HP_1) produced farther backwards than in other species, the tapered extremity flexed upwards. Posterior process of right hemitergite ($10RP_1$) tapered, directed backwards. Dorsal process of right hemitergite ($10RP_2$) with an extra posterior lobe near the point of attachment, directed towards the left. Left hemitergite with its process ($10LP$) flattened, expanding slightly terminally, ending in two spines separated by a concavity which forms the distal edge of the process. Left cercus-basipodite (LCB) subconical, outer margin sinuous and chitinized, remainder membraneous. Seven ♂ examined in detail.

♀. *Length* 9·9–13·6 mm.; head, length 1·79–2·21 mm., breadth 1·44–1·70 mm. Length of apparently complete antennae 1·7–2·0 times the corresponding head-breadth, with 19 segments. *Colour*: Head golden-brown with dark-brown tracery, eyes black, pronotum dark brown with pale-brown pattern; other tergites as in the ♂. Pleurites dark golden-brown. Sternites merging from cream at centre to golden-brown at lateral margins, ninth abdominal sternite dark brown throughout. Segments of antennae, legs and cerci as in the ♂. Intersegmental membranes more in evidence than in the ♂. Fourteen ♀ examined.

Type Locality: Mouth of Bega River, north side (Map 1, 11A), 7.10.37, amongst dead leaves.

Distribution of Types: As for *M. illawarrae illawarrae*.

METOLIGOTOMA PUGIONIFER, n. sp. Figs. 88–92.

♂. *Length* 12·6–16·5 mm.; head, length 2·40–3·04 mm., breadth 1·86–2·37 mm. Length of apparently complete antennae 2·2 times the corresponding head-breadth, with 20 segments. *Colour*: Head dark brown, eyes black; thoracic and abdominal tergites dark brown, pronotum with golden-brown pattern, metascutum and abdominal tergites with pale mid-dorsal line and golden-brown lateral flecking. Pleurites dark brown, sternites golden-brown, the anterior abdominal sternites paler medially, the hypandrium dark brown throughout. Segments of antennae, legs and cerci dark golden-brown, paler near joints. Intersegmental membranes (little visible) cream. *Head* (fig. 88) with the lateral margins behind the eyes slightly sinuous, and converging slightly posteriorly. *Terminalia* (figs. 89–92):

Posterior process of right hemitergite (10RP$_1$) tapered, directed backwards and inwards; dorsal process of right hemitergite (10RP$_2$) directed forwards and to the left, the free margins sinuous. Process of left hemitergite (10LP), as viewed from above, with a broad curved spine projecting to the left and slightly forwards, arising almost from the extremity of the process, which is obtusely tapered. Left cercus (LC) as in the preceding species but with less curvature. Left cercus-basipodite (LCB) papillose in form, largely membraneous. Five ♂ examined.
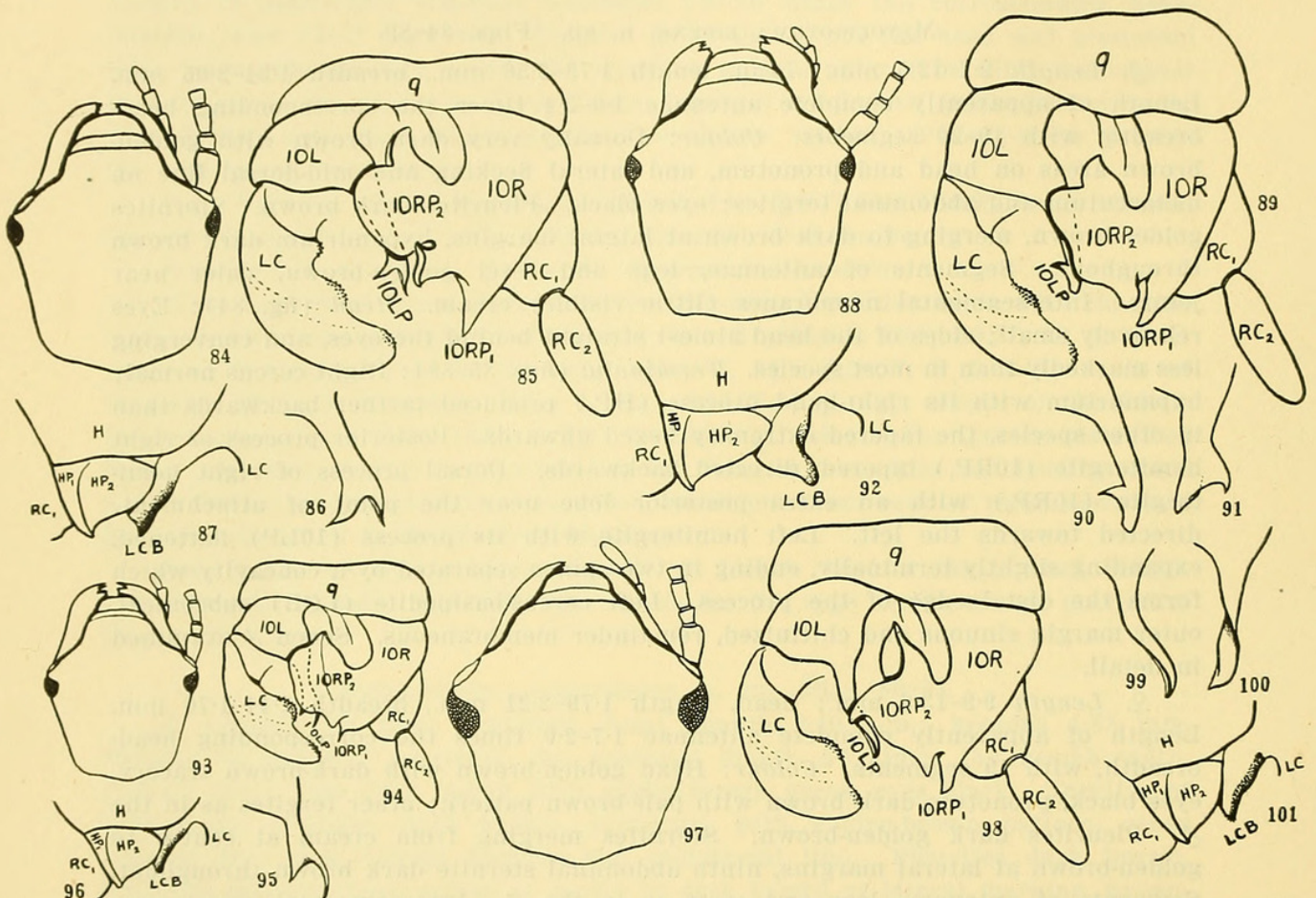
Figs. 84-87.—*Metoligotoma bidens*, n. sp., corresponding structures, magnifications and lettering to figs. 1-4.

Figs. 88-92.—*Metoligotoma pugionifer*, n. sp. Figs. 88-90, 92, corresponding structures, magnifications and lettering to figs. 1-4. Fig. 91, as fig. 90, but viewed lateroventrally (from the left).

Figs. 93-96.—*Metoligotoma minima*, n. sp., corresponding structures, magnifications and lettering to figs. 1-4.

Figs. 97-101.—*Metoligotoma begae*, n. sp. Figs. 97-99, 101, corresponding structures, magnifications and lettering to figs. 1-4. Fig. 100 as fig. 99, but viewed lateroventrally (from the left).

Type Locality: Slopes of The Little Dromedary, Central Tilba (Map 1, 12A), 6.10.37, amongst dead leaves.

As the males of this species were collected in close proximity to males of *M. brevispina*, no female types could be selected or described.

Distribution of Types: Holotype ♂ and paratype ♂ in the Macleay Museum. Paratype males forwarded to the British Museum, the Leyden Museum, and the Western Australian Museum.

METOLIGOTOMA MINIMA, n. sp. Figs. 93–96.

♂. *Length* 6·7–8·9 mm.; head, length 1·38–1·89 mm., breadth 1·06–1·50 mm. Length of apparently complete antennae 2·1–2·9 times the corresponding head-breadth, with 17–19 segments. *Colour*: Head black, shiny, eyes black; thoracic and abdominal tergites dark brown (almost black) shiny; pleurites and sternites dark golden-brown, hypandrium very dark brown. Segments of antennae, legs and cerci dark brown, paler near joints. Intersegmental membranes (very little visible) pale brown. The dark, shiny coloration of this species is exceptional amongst the related species. *Head* (fig. 93) with the sides converging behind the eyes and almost straight. *Terminalia* (figs. 94–96): Structurally close to those of *M. convergens*, of which this may actually be a subspecies. The posterior process of the right hemitergite (10RP$_1$) is directed straight back, not to the right; the dorsal process of the right hemitergite (10RP$_2$) has the free edge smoothly sinuous; the lateral spine of the process of the left hemitergite (10LP) arises from a broader base, and the portion of the process distad to the spine is more slender and acute than in *M. convergens*. The left cercus is more obtuse distally, with a more prominent lobe or tooth on the inner margin. Twenty-six ♂ from the type locality examined.

♀. Only a single ♀ (the allotype) is described; although more than 30 females were collected when the type males were secured, their close resemblance to the females of *Notoligotoma nitens* Davis, which was collected in association with *M. minima* in this district, rendered identification uncertain. The allotype was collected in a nest occupied, in addition, only by the holotype ♂. *Length*: 8·3 mm.; head, length 1·41 mm., breadth 1·09 mm. Antennae incomplete. *Colour*: Head, and tergites of thorax and abdomen, dark golden-brown, eyes black, pale mid-dorsal line in thoracic and abdominal regions. Pleurites and sternites more or less uniform golden-brown, eighth abdominal sternite dark brown at lateral margins, ninth dark brown throughout. Segments of antennae, legs and cerci dark golden-brown, paler near joints. Intersegmental membranes (a fair amount visible) cream.

Type Locality: Near Brogo (Prince's Highway, ½ mile north-east of Brogo; Map 1, 13A), 8.10.37, amongst dead leaves in crevices of rocks.

Distribution of Types: Holotype ♂, paratype ♂ and allotype ♀ in the Macleay Museum. Paratype males forwarded to the British Museum, the Leyden Museum and the Western Australian Museum.

Additional Locality: North of Dry River at Quaamaa (Map 1, 13B), 8.10.37, 11 ♂, length 7·6–10·3 mm.; head, length 1·38–2·02 mm., breadth 1·09–1·66 mm.— i.e., of larger average size than type series. Also 8 ♀, not definitely referable to the males on account of the occurrence in this locality of *Notoligotoma nitens*. Males of this series, which agrees in structure and colour with the type series, lodged in the Macleay Museum.

METOLIGOTOMA BEGAE, n. sp. Figs. 97–101.

♂. *Length* 7·6–13·1 mm.; head, length 1·34–2·72 mm., breadth 1·15–2·24 mm. Length of apparently complete antennae 2·0–2·9 times the corresponding head-breadth, with 19–20 segments. *Colour*: Head very dark brown with black tracery, eyes black. Tergites of thorax and abdomen dark brown, pronotum with pale golden-brown pattern, other tergites with pale mid-dorsal line and lateral spots. Pleurites dark brown. Sternites merging from cream at centre to dark golden-brown at lateral margins, prosternum and hypandrium dark brown throughout.

Segments of antennae and legs golden-brown, paler near joints, the femora with paler areas; cerci pale brown. Intersegmental membranes (little visible) cream. *Head* (fig. 97): Eyes prominent, sides of head behind eyes converging strongly posteriorly, with a swelling midway between the eyes and the posterior limit. *Terminalia* (figs. 98–101): Closely resembling *M. illawarrae* (especially the type subspecies). Right hemitergite (10R) and its process (10RP$_1$, 10RP$_2$) with only minor differences; left cercus (LC) similar to that in *M. illawarrae illawarrae*, the concavity basad to the distal part of the inner face less markedly incised. Process of left hemitergite (10LP) simple, slender and sinuous, the termination twisted about a longitudinal axis and presenting a flattened cultriform appearance in lateral view. Left cercus-basipodite subconical, not, as in all the subspecies of *M. illawarrae*, produced terminally to a spine, but with a series of short, stout setae in a terminal position, all of approximately equal size. Fifteen ♂ from the type locality examined in detail.

♀. *Length* 10·1–16·3 mm.; head, length 1·76–2·08 mm., breadth 1·41–1·66 mm. Length of apparently complete antennae 1·9–2·3 times the corresponding head-breadth, with 18–21 segments. *Colour*: Head golden-brown with dark-brown tracery, eyes black. Tergites, pleurites and sternites as in the ♂, the ninth abdominal sternite dark brown throughout. Segments of antennae, legs and cerci golden-brown, paler near joints, femora with paler areas. Intersegmental membranes (a fair amount visible) cream. Fifteen ♀ from the type locality examined.

Type Locality: Near Bega (Prince's Highway, two miles north of Bega; Map 1, 14A), 2.9.37 and 8.10.37, amongst dead leaves.

Distribution of Types: As for *M. illawarrae illawarrae*.

Other Localities: Specimens from the following localities agree with the type series in colour and structure: Tathra (Map 1, 14B), 7.10.37, 13 ♂, 21 ♀; near Brogo (Prince's Highway, one mile south of Brogo Bridge; Map 1, 14C), 8.10.37, 7 ♂, 9 ♀. Identified specimens from these localities lodged in the Macleay Museum.

Size limits for all series examined: ♂, as for type series; ♀, length 9·9–16·3 mm.; head, length 1·54–2·08 mm., breadth 1·22–1·73 mm.

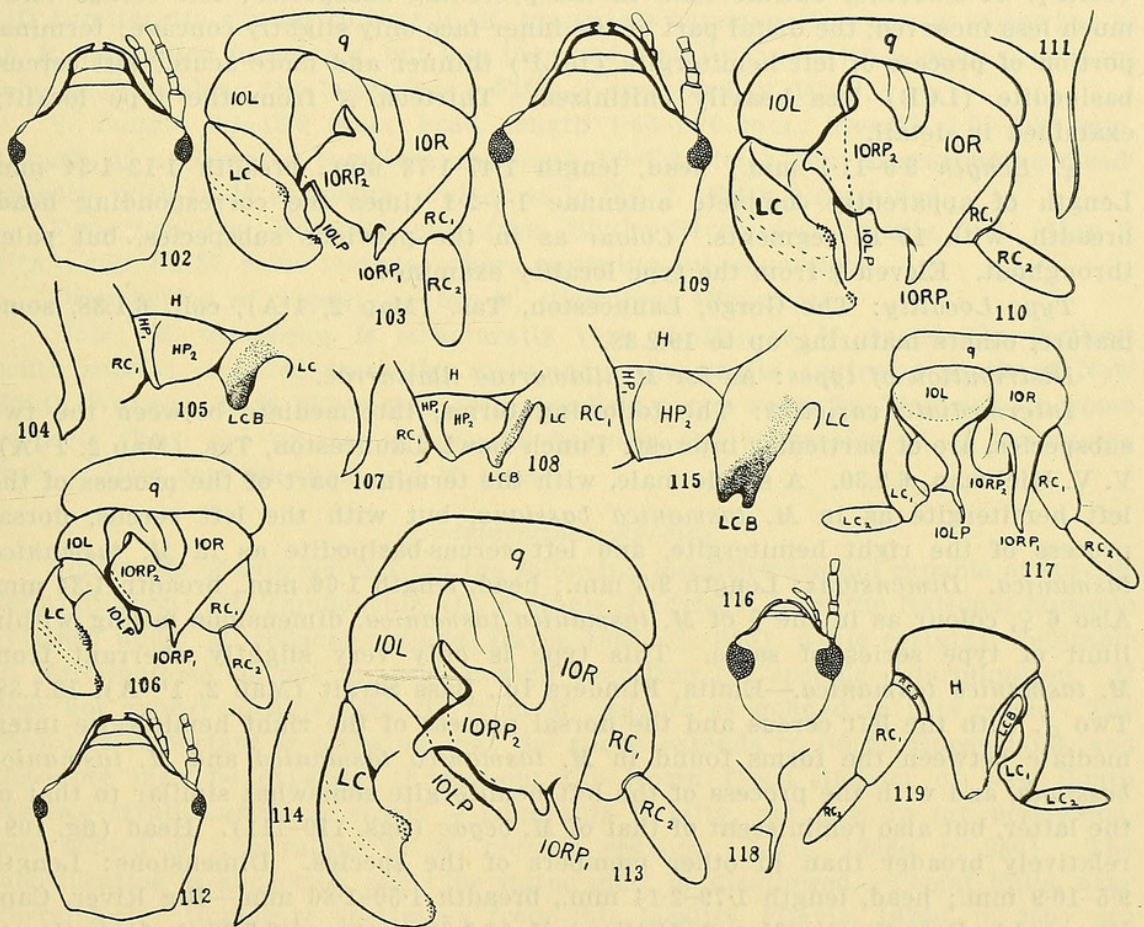METOLIGOTOMA TASMANICA TASMANICA, n. sp. et subsp. Figs. 102–105.

♂. *Length* 9·0–10·9 mm.; head, length 1·47–2·08 mm., breadth 1·22–1·66 mm. Length of apparently complete antennae 1·6–3·0 times the corresponding head-breadth, with 17–19 segments. *Colour*: Head dark brown (almost black), eyes black. Thoracic and abdominal tergites very dark brown with paler pattern on pronotum, pale mid-dorsal line and lateral flecking on metascutum and abdominal tergites. Pleurites dark brown; sternites ranging from golden-brown at centre to dark brown at lateral margins, hypandrium dark brown throughout. Segments of antennae, legs and cerci dark brown, paler near joints, femora with paler areas. Intersegmental membranes (little visible) cream. *Head* (fig. 102): Sides of head converging markedly from the eyes to the posterior limit, slightly sinuous. *Terminalia* (figs. 103–105): Right hemitergite and its processes similar in general form to those of *M. illawarrae illawarrae*. Process of left hemitergite (10LP) slender and sinuous, the extremity expanded to a more or less rhomboidal plate. Left cercus (LC) greatly incurved distally, with a distal concavity on the inner face, basad to which is a rounded lobe. Left cercus-basipodite (LCB) bluntly subconical, heavily chitinized distally and along the outer side, which is sinuous. Twenty-one ♂ from the type locality examined in detail.

♀. *Length* 8·4–12·4 mm.; head, length 1·34–1·76 mm., breadth 1·18–1·38 mm. Length of apparently complete antennae 1·7–2·0 times the corresponding head-breadth, with 16–17 segments. *Colour*: As in the ♂, but somewhat paler, head dark brown, usually with golden-brown areas, ninth abdominal sternite dark brown throughout; more of the intersegmental membranes visible than in the ♂. Eleven ♀ from the type locality examined.

Type locality: Summit of Mt. Nelson, Tas., 1,100 feet (Map 2, 1A), coll. 24.1.37 and 8.2.37, some mature, others maturing up to 12.3.37. Amongst dead leaves on and between boulders.

Distribution of types: As for *M. illawarrae illawarrae*.

Other localities: Specimens from the following localities agree with the type series in structure and colour: Slopes of Mt. Nelson, Tas., 400 ft. (near type locality; Map 2, 1A), coll. 11.2.37 and 12.2.37, some mature, others maturing up to 12.3.37, 7 ♂, 12 ♀; Bellerive, Tas. (Map 2, 1B), coll. 8.2.37, maturing subsequently,

Figs. 102–105.—*Metoligotoma tasmanica tasmanica,* n. sp. et subsp., corresponding structures, magnifications and lettering to figs. 1–4.

Figs. 106–108.—*Metoligotoma tasmanica bassiana,* n. subsp., corresponding structures, magnifications and lettering to figs. 2–4.

Figs. 109–111.—*Metoligotoma tasmanica,* specimens from Emita, Flinders Id., showing characters intermediate between subspecies *tasmanica* and *bassiana*. Corresponding structures, magnifications and lettering to figs. 1–3.

Figs. 112–115.—*Metoligotoma tasmanica biloba,* n. subsp., corresponding structures, magnifications and lettering to figs. 1–4.

Figs. 116–119.—*Oligotoma approximans,* n. sp., corresponding structures, magnifications and lettering to figs. 1–4. (LC$_1$, LC$_2$, first and second segments of left cercus; RCB, right cercus-basipodite.)

Mrs. G. L. Davis, 11 ♂, 6 ♀; near Denne's Point, North Bruni Island, Tas. (Map 2, 1C), 30.1.38, 5 ♂, 5 ♀; Simpson's Bay, South Bruni Island, Tas. (Map 2, 1D), 21.1.38, 3 ♂, 2 ♀. Identified specimens from these additional localities have been deposited in the Macleay Museum.

Size limits for all series examined: ♂, length 7·7–12·5 mm.; head, length 1·47–2·75 mm., breadth 1·22–2·14 mm. ♀, length 8·4–13·0 mm.; head, length 1·34–1·95 mm., breadth 1·18–1·54 mm.

METOLIGOTOMA TASMANICA BASSIANA, n. subsp. Figs. 106–108.

♂. *Length* 8·1–10·5 mm.; head, length 1·44–1·98 mm., breadth 1·09–1·54 mm. Length of apparently complete antennae 2·1–2·9 times the corresponding head-breadth, with 15–18 segments. *Colour* as in the previous subspecies, but paler throughout. *Head* not structurally distinguishable from that of the preceding subspecies. *Terminalia* (figs. 106–108): Dorsal process of right hemitergite (10RP$_2$) of smoother outline than in the preceding subspecies; left cercus (LC) much less incurved, the distal part of the inner face only slightly concave; terminal portion of process of left hemitergite (10LP) thinner and more acute; left cercus-basipodite (LCB) less heavily chitinized. Thirteen ♂ from the type locality examined in detail.

♀. *Length* 9·0–11·1 mm.; head, length 1·47–1·73 mm., breadth 1·12–1·34 mm. Length of apparently complete antennae 1·8–2·1 times the corresponding head-breadth, with 15–18 segments. *Colour* as in the previous subspecies, but paler throughout. Eleven ♀ from the type locality examined.

Type Locality: The Gorge, Launceston, Tas. (Map 2, 1'A), coll. 6.1.38, some mature, others maturing up to 19.2.38.

Distribution of types: As for *M. illawarrae illawarrae*.

Intermediate varieties: The following forms, intermediate between the two subspecies, are of particular interest: Punch Bowl, Launceston, Tas. (Map 2, 1''A), V. V. Hickman, 6.9.30. A single male, with the terminal part of the process of the left hemitergite as in *M. tasmanica bassiana*, but with the left cercus, dorsal process of the right hemitergite, and left cercus-basipodite as in *M. tasmanica tasmanica*. *Dimensions*: Length 9·3 mm.; head, length 1·66 mm., breadth 1·34 mm. Also 6 ♀, colour as in the ♀ of *M. tasmanica tasmanica*, dimensions falling within limit of type series of same. This type is only very slightly aberrant from *M. tasmanica tasmanica.*—Emita, Flinders Id., Bass Strait (Map 2, 1'''A), 13.1.38. Two ♂, with the left cercus and the dorsal process of the right hemitergite intermediate between the forms found in *M. tasmanica tasmanica* and *M. tasmanica bassiana*, and with the process of the left hemitergite somewhat similar to that of the latter, but also reminiscent of that of *M. begae* (figs. 110–111). Head (fig. 109) relatively broader than in other members of the species. Dimensions: ʼLength 9·5–10·9 mm.; head, length 1·79–2·14 mm., breadth 1·50–1·86 mm.—Big River, Cape Barren Id., Bass Strait (Map 2, 1'''B), coll. 18.1.38, matured 9.5.38, 1 ♂, similar to those from Emita but larger (length 11·8 mm.; head, length 2·24 mm., breadth 1·86 mm.).

Specimens from the following localities on Flinders Island are probably referable to the Emita specimens, but mature males have not been secured: Palana (Map 2, 1?A), 11.1.38 (forming webs in dead leaves of *Leptospermum laevigatum*, on the ground or, more frequently, in sand collected in the forks of the *Leptospermum* trees several feet above the ground); Mt. Strzelecki, at 1,500 feet (Map 2, 1?B), 7.1.38, amongst fallen leaves; and Lady Barron (Map 2, 1?C),* 9.1.38,

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* One male from this locality matured in culture (14.6.38); it is similar in structure and colour to males from Emita and Cape Barren Id., agreeing with the latter in size.

amongst fallen *Leptospermum* leaves. The size of adult females and penultimate instar males from these three localities indicates that members of these colonies are considerably larger than those of the Emita colony.

METOLIGOTOMA TASMANICA BILOBA, n. subsp. Figs. 112–115.

♂. *Length* 7·6–14·4 mm.; head, length 1·41–2·30 mm., breadth 1·12–1·76 mm. Length of apparently complete antennae 1·6–2·0 times the corresponding head-breadth, with 16–18 segments. *Colour* as for *M. tasmanica bassiana*. Head (fig. 112) similar to the two preceding subspecies in general form. *Terminalia* (figs. 112–115): Immediately separable from the other subspecies by the bilobed form of the left cercus-basipodite (LCB). The extra lobe arises subterminally on the outer side of the main structure, and is, with the adjacent part of the main structure, heavily chitinized.

Right hemitergite and its processes as in *M. tasmanica tasmanica*; process of left hemitergite similar to that in *M. tasmanica bassiana*; left cercus somewhat as in *M. tasmanica tasmanica*, but less incurved distally, and with a more prominent lobe midway along the inner face. Fifty ♂ examined in detail.

♀. *Length* 9·1–13·9 mm.; head, length 1·40–1·70 mm., breadth 1·09–1·28 mm. Length of apparently complete antennae 1·9–2·3 times the corresponding head-breadth, with 16–17 segments. *Colour* as in the ♂. Fifty ♀ examined.

Type Locality: Recorded only from Blythe River, near Burnie, Tas. (Map 2, 1^iv A), coll. 6.1.37, some mature, others maturing subsequently.

Distribution of Types: As for *M. illawarrae illawarrae*.

Note: *M. tasmanica* is structurally very similar to *M. begae*, the farthest south species recorded from the mainland of Australia (extreme south of New South Wales). It is likely that corresponding forms occur in Victoria. In some respects there are greater differences between the subspecies of *M. tasmanica inter se* than between them and *M. begae*.

Undetermined Species.

Specimens of this genus from the following localities are not capable of specific determination: Mt. Tambourine, Q.: A single ♂ (dried), from the National Museum (classed under *M. reducta reducta*, Davis, 1936a, p. 250), while certainly referable to *Metoligotoma*, is not in good enough condition for specific determination. It does not appear to differ greatly from *M. reducta* as defined in this paper. The record is important in showing that the genus extends to South Queensland, and therefore may be expected throughout the North Coast district of New South Wales.—Myall Lakes: A single ♂ from this locality, not now in my possession, was named as a paratype of *M. reducta reducta* (Davis, 1936a, p. 250). The identification is uncertain, and type status must be disallowed.—Tomat Falls, near Yerranderie: Immature specimens from this locality (Davis, 1936a, p. 250) are referable to the genus, the species being doubtful. The locality is difficult of access, but, in view of the proximity to Jooriland, Upper Burragorang, and the similarity of situations, this material is probably referable to *M. illawarrae*. The same applies to immature specimens from Lower Burragorang, listed under *M. reducta reducta* (l.c.).—Warrandyte, Vic., G. F. Hill, date unrecorded: Two immature specimens constitute the only record for the genus from Victoria, although it would be apparent from its presence in New South Wales and Tasmania that it occurs in parts of Victoria.—Pulpit Rock, Bagdad Valley, Tas. (Map 2, 1?E), G. H. Hardy, 8.11.14: A series containing no adult males, but probably referable to *M. tasmanica tasmanica*. The earliest record for this genus, this series is

referred to by Tillyard (1926, p. 123) as 'an undescribed species' (of *Oligotoma*). I have twice visited this district (31.1.37; 4.2.38), securing no specimens of this genus, but only *Oligotoma gurneyi gurneyi*; it transpires that the name 'Pulpit Rock' is locally applied to two distinct localities, the locality examined not being that from which Hardy's material was taken.

Key to the Species and Subspecies of Metoligotoma.

The following key, admittedly artificial, serves to distinguish the known species and subspecies of the genus. The characters are for the males. Abbreviations for the structures, as used on the figures and explained under figures 2 and 4, are employed.

1. 10LP a flat subrectangular plate, the minimum breadth at least one-quarter the length; 10RP$_2$ with a slenderly-tapered lobe directed backwards and to the right above 10RP$_1$ .... *anomala*, nov.
   10LP more slender, of diverse form; 10RP$_2$ not as above 2
2. 10LP ending in an ovoid concave spoon-shaped structure basad to which is a rounded lobe .... *intermedia*, nov.
   10LP not as above 3
3. 10LP bearing a spine (other than the terminal spine) 4
   10LP without a spine, except in some species the acute extremity of the main process 9
4. Extremity of 10LP flat and rounded, with a short subterminal spine arising on the dorsal side; HP$_1$ with a spathulate terminal expansion .... *brevispina*, nov.
   10LP not as above; HP$_1$ evenly tapered 5
5. 10LP with a lateral spine arising well basad to its extremity 6
   10LP not as above 8
6. Termination of 10LP bluntly truncate .... *pentanesiana* Davis.
   Termination of 10LP slenderly tapered 7
7. 10RP$_1$ directed outwards; free edges of 10RP$_2$ crenulate .... *convergens*, nov.
   10RP$_1$ directed backwards; free edges of 10RP$_2$ smooth .... *minima*, nov.
8. 10LP ending in two sharp spines directed outwards in opposite directions ....
   .... *bidens*, nov.
   10LP ending obtusely, with a flat subterminal lateral spine .... *pugionifer*, nov.
9. LCB produced terminally to a sharp spine 10
   LCB not as above 12
10. Distal portion of inner face of LC only very slightly concave, and nearly half as long as whole structure .... *illawarrae illawarrae*, nov.
    Distal part of inner face of LC shorter and more concave 11
11. Termination of LC evenly rounded .... *illawarrae septentrionis*, nov.
    Termination of LC somewhat tapered .... *illawarrae telocera*, nov.
12. 10RP$_1$ slenderly falciform, directed inwards 13
    10RP$_1$ directed backwards or, if inwards, then short and blunt 15
13. 10LP ending acutely 14
    10LP ending obtusely .... *extorris* Davis.
14. LC with terminal portion slenderly tapered; head-breadth (for series examined) 1·18-1·60 mm. .... *collina exigua*, nov.
    LC with terminal portion broader; head-breadth (for series examined) 1·50-2·24 mm. (overlapping in part with former subspecies) .... *collina collina*, nov.
15. 10LP much curved, fitting into ventral groove of LC .... *ingens* Davis.
    10LP little curved; LC without ventral groove 16
16. 10RP$_1$ very short and blunt, directed inwards .... *reducta* Davis.
    10RP$_1$ tapered, directed backwards 17
17. Terminal portion of 10LP twisted about longitudinal axis .... *begae*, nov.
    Terminal portion of 10LP not so twisted 18
18. LCB bilobed .... *tasmanica biloba*, nov.
    LCB simple 19
19. Termination of 10LP cultriform; distal portion of inner face of LC only slightly concave; free edges of 10RP$_2$ of smooth outline .... *tasmanica bassiana*, nov.
    Termination of 10LP subrhomboidal; distal portion of inner face of LC very concave; free edges of 10RP$_2$ crenulate .... *tasmanica tasmanica*, nov.

Inter-relation of species of Metoligotoma.

Certain species—*M. anomala*, *M. intermedia*, *M. ingens* and possibly *M. brevispina*—appear to lie away from any close affinity, mutual or to other

groups; others may be assigned to small "blocs". Thus *M. collina* and *M. extorris* seem to be clearly related structurally, and also geographically (with an intermediate region, about Goulburn, with no records); a similar "bloc" is formed by *M. pugionifer* and *M. bidens*, and by *M. convergens* and *M. minima*. To the latter group *M. brevispina* may possibly be referred; the other species structurally akin to *M. convergens* and *M. minima* on certain characters (*M. pentanesiana*) is probably convergent, as the respective distributions weigh against close direct relationship. The structural affinities between *M. illawarrae*, *M. begae* and *M. tasmanica* are rather marked; between the region occupied by the first and second there is a considerable zone populated by other types, with no records of this "bloc", but the structural resemblance is present in too many characters to postulate convergence with assurance, especially since comparison with other species indicates that the group of characters expressing the relationship is almost certainly not linked genetically. The true perspective on the relationship between *M. begae* and *M. tasmanica* can only be obtained by examination of material from Eastern Victoria. I am unable to refer *M. reducta* to any special group, although it does not stand as far from the general type as *M. anomala*, *M. intermedia* or *M. ingens*.

Since, according to modern interpretation, the onus of determining which differences shall be considered specific, and which subspecific or of lower category, rests entirely on the specialist dealing with the group in question, it is advisable to give some reasons for the course adopted, however arbitrary the system may appear. I have been guided in several cases by the occurrence of two forms with geographic ranges different for the most part, but common for a limited area. Where, in this zone of overlap, the two forms have kept their identity and shown no trace of intergradation, I have taken their status as that of distinct species. In some cases specific status has been given without the actual discovery and study of an overlap zone. I consider that geographic races (subspecies) of one species should show a continuous gradation of structure and distribution; when this is not so, that is, when structural changes are sudden in a short spatial distance, or when forms apparently related by structure possess an anomalous distribution (e.g. *M. illawarrae* and *M. begae*), it seems that we are dealing with distinct species, which may be closely allied naturally, or may be only superficially related on account of convergence. With regard to those forms recognized as subspecies, *M. tasmanica tasmanica* and *M. tasmanica bassiana* have intermediates in structure with a more or less intermediate distribution; but the zone between the localities of *M. tasmanica bassiana* and *M. tasmanica biloba* has not yet been examined. In the case of *M. collina* and *M. collina exigua*, there are no intermediate records; actually, the type series of the former (from near Picton) shows no size overlap with the type series of the latter (from Wentworth Falls), but another series of *M. collina collina* (from near Mittagong) shows a small overlap in size with *M. collina exigua*. Mittagong, though further horizontally from Wentworth Falls than is Picton, is intermediate in altitude.

Although *M. illawarrae illawarrae* and *M. illawarrae septentrionis* have a regular distribution, the former centred to the south of the latter (Map 1, 2A–G, J; and 2'A–B resp.), and a series including both forms with intermediates is recorded in an intermediate geographic position (Map 1, 2K, 2'C), the problem is complicated by the occurrence of a typical colony of the southern subspecies (*M. illawarrae illawarrae*) to the north of the records for *M. illawarrae septentrionis* (see Map 1, 2H). The subspecific status here, and in the case of *M. illawarrae telocera*, is provisional. In fact, many of the taxonomic facts may need review when further

records are obtained, e.g., *M. minima* and *M. convergens* may be subspecies and not distinct species. The classification submitted in this paper is of a temporary nature, but, if judgment were reserved until all localities in Eastern Australia had been examined, it would be reserved indefinitely.

Individual variation in the male terminalia for conspecific members of one colony is exceptional, being observed chiefly in *M. extorris*, the only other noteworthy case being *M. illawarrae telocera*. For *M. extorris*, a number of locality records and some long series have shown that, in addition to individual variation, there is a certain structural variation from the norm for some colonies, but a full review of the facts suggests that this is not to be recognized under definite racial or varietal names. In addition, there are in this species certain colonies of larger or smaller average size, but here again the differences seem to be merely local and not racial (subspecific). The size differences are probably genotypic rather than phenotypic; it has been noted in cultures of various species that adults reared under conditions of artificial drought tend to be below the average size, but the colonies of *M. extorris* of smaller average size range in the field from moderately moist conditions (Brush Id.) to fairly dry (Ulladulla), and those of larger average size from damp (Bateman's Bay) to moderately dry (near Moruya Heads) and dry (Mogo), these conditions depending on aspect, drainage and soil type.

Questions involving the distribution of the genus *Metoligotoma* are discussed at the end of the paper.

OLIGOTOMA Westwood, 1836.
OLIGOTOMA APPROXIMANS, n. sp. Figs. 116–119.

♂. *Length* 6·3–6·9 mm.; head, length 1·02–1·06 mm., breadth 0·90 mm.; forewing, length 5·8–7·2 mm., breadth 1·5–1·7 mm.; hindwing, length 4·8–5·9 mm., breadth 1·4–1·7 mm. Antennae up to 3·5 mm. long, with 18 segments. *Colour*: Golden-brown, the head slightly darker, eyes black; wing veins, which are similar in arrangement to those of other members of the genus, bordered with pale brown bands. *Head* (fig. 116) smoothly rounded, eyes prominent; mandibles as in *O. glauerti* Till. *Terminalia* (figs. 117–119): Right hemitergite and its processes similar to *O. gurneyi gurneyi* Frogg., with the outer process slender and smoothly tapered. Process of left hemitergite (10LP) of very characteristic form, terminally tapering to a point, slightly incurved, and with a subterminal flat acute projection directed to the left. 10LP approximates to its homologue in *Metoligotoma minima*. Right cercus as in all members of the genus *Oligotoma*; left cercus with its first segment (LC₁) clavate, produced inwards subterminally as in *O. gurneyi centralis* Davis; second segment (LC₂) normal, subcylindrical. Hypandrium (H) tapered distally, ending truncately; left cercus-basipodite (LCB) cuneiform, embedded in membrane between the hypandrium and the base of the left cercus.

♀ unknown.

Locality: Fremantle, W.A., 20–23.5.35, K. R. Norris (holotype ♂, paratype ♂). Specimens placed in the Macleay Museum.

OLIGOTOMA GURNEYI GURNEYI Frogg.

It had been noted (Davis, 1936a, p. 241) that *O. gurneyi agilis* Frogg. from Wagga,* and *O. gurneyi hilli* Davis, from Cotter Reservoir, F.C.T., might prove to be local varieties of *O. gurneyi gurneyi* Frogg. It is evident from data detailed

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* Tillyard (1926, p. 123) refers to *O. gracilis* Frogg. from Wagga, a lapsus calami for *O. agilis*.

below that both subspecies must be rejected as synonyms of *O. gurneyi gurneyi*, which therefore has a forma aptera. Hereafter, *O. gurneyi agilis* is referred to as the Wagga series, and *O. gurneyi hilli* as the Cotter series, of *O. gurneyi gurneyi*.

In the first place, a colony from Burnie, Tas. (coll. 5.1.37, matured 18.2.37 et seq.) contained winged and wingless males. Similar occurrences were noted in colonies from near Launceston, Tas. (coll. 21.1.37, matured 23.2.37 et seq.) and Pulpit Rock, Bagdad Valley, Tas. (4.2.38). These males had terminalia identical with *O. gurneyi gurneyi* from the mainland (including the Cotter and Wagga series). A colony from Blythe, near Burnie, Tas. (coll. 3.1.37, matured 1.3.37 et seq.) appeared to have all the males wingless; while a colony from Hobart (coll. 27.1.37, matured subsequently) appeared to have all the males winged.

Although the Cotter and Wagga series showed no signs of overlap *inter se* as regards total length, a wingless male from Burnie was 9·1 mm. long, intermediate between the Cotter (maximum 8·7 mm.) and Wagga (minimum 9·7 mm.) series. In this example the ratio of head-length to maximum breadth was 10·0:7·9; the average calculated for the Cotter series was 10·0:6·9, and for the Wagga series 10·0:8·6. This ratio must be regarded as variable, in Tasmanian examples extending from 10·0:7·7 to 10·0:8·6 for winged males, and from 10·0:7·6 to 10·0:8·1 for wingless males. The total lengths of other wingless males from Tasmania lay within the limits given for the Cotter series.

It is clear that the presence or absence of wings cannot be used in this species as a systematic (subspecific) criterion. Moreover, winged males from the Australian mainland cover almost the complete size range for the Cotter and Wagga series, including the zone intermediate between these series. Although on a frequency graph for total length for the Cotter and Wagga series there are two well-marked peaks and, for the numerous specimens examined, an intermediate zone of zero frequency;* and although such a graph would normally justify the retention of the distinction as geographic races, nevertheless the occurrence of intermediates outside, and not between, the Cotter and Wagga localities (wingless intermediates in Tasmania, and winged forms intermediate in length in various New South Wales and Victorian localities) makes it necessary to abandon the subspecific names *agilis* Frogg. and *hilli* Davis. The allotype ♂ of *O. gurneyi agilis* and the holotype ♂ of *O. gurneyi hilli*, in the Macleay Museum, are named morpho-types of the forma aptera of *O. gurneyi gurneyi*.

Although no taxonomic status can be allowed for the Cotter series on the above facts, specimens of this type (of small size, males apterous, maturing mostly about May and June, colonies amongst lichen on rocks) appear to form something of a unit in this district; closely comparable colonies have been observed nearby at Lake George (coll. 3.6.37) and on high land nearer the coast and to the south (Mt. Imlay, nr. Eden, at 2,800 feet, coll. 29.3.37, matured subsequently). No colonies of other types are known from this area.

The colour of the winged males taken in Tasmania was, after some time from the last ecdysis, the same as that of wingless males taken with them and on the mainland, the sclerites being dark red-brown instead of golden-brown, the head dark brown throughout, and the wing-veins bordered with broad, dark brown bands. This is regarded as the mature colour, the paler forms described before (Davis, 1936a, p. 231) probably being not fully darkened after ecdysis. Certain measurements of the Tasmanian examples are given herewith as extending the size limits

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* A frequency graph of the more reliable head-capsule length measurement for the Cotter and Wagga series would also give two marked peaks, but the intermediate zone would not have a frequency of zero.

previously given: Winged ♂, head-length 1·12 mm.; forewing 6·2 × 1·5 mm.; hind-wing 5·1 × 1·5 mm. Female, total length 7·4 mm. All these measurements are below the previous minima for the subspecies, but other winged males, and females, from Tasmania, lay within the previous limits. In general it may be said that the colder localities appear to give individuals of smaller size.

The phenomenon of dimorphic males has been recorded for *Anisembia texana* (Mel.) (Melander, 1902, 1903), *Oligotoma japonica* Okajima (Okajima, 1926) and *Notoligotoma nitens* Davis (Davis, 1936a). The occurrence of colonies in which all the males are winged, or all wingless, as noted in *O. gurneyi*, and also in a few cases in *N. nitens*, suggests that the presence or absence of wings in these species is caused by a simple genetic factor (sex-limited), pure colonies deriving from a single male or several of the same form, and mixed colonies deriving from a mixed stock. It is worthy of note that, with one exception, all colonies with winged males of *O. gurneyi gurneyi* from the mainland have been in trees or fences, while the wingless forms (from Cotter Reservoir, Lake George, Wagga and Mt. Imlay) have been ground-living forms. Two of the mixed colonies from Tasmania were from the bark of trees, one (Bagdad Valley) from lichen on rocks; the pure wingless colony from Blythe, Tas., was from lichen on rocky ground, and the pure winged colony from Hobart, Tas., was chiefly in a decayed fence, but also extended to the rocky face of a quarry.

The wingless ♂ from Lady Julia Percy Id., Vic. (Davis, 1936a, p. 239) can now be regarded as a forma aptera of the Lucindale and Adelaide (S.A.) specimens described in the same place, but whether this series is to be referred to a separate subspecies, or to *O. gurneyi gurneyi* × *O. gurneyi centralis*, must remain undecided until further collecting has been carried out in this region. Males from Chinchilla, Q. (—.5.35, per A. P. Dodd), another point in the zone intermediate between those of the above subspecies, but in a different sector from Lucindale and Adelaide, are exactly similar to *O. gurneyi gurneyi*, except in the outer process of the right hemitergite ($10RP_1$), which is as in *O. gurneyi centralis*. The Lucindale–Adelaide specimens differ from *O. gurneyi gurneyi* chiefly in having the left cercus-basipodite as in *O. gurneyi centralis*.

The recognition of a forma aptera of *O. gurneyi gurneyi* renders more probable the identification as *O. gurneyi gurneyi* of the series from Pyrmont (Froggatt, 1905; Friederichs, 1923; see also Davis, 1936a, p. 237, note).

Additional localities for *O. gurneyi gurneyi*, in the Furneaux Group, Bass Strait, indicate the means of entry of this subspecies into Tasmania (as discussed later). The following localities are recorded: The Bluff, nr. Whitemark, Flinders Id., 6.1.38; East Sister Id., 12.1.38; West Sister Id., 11.1.38 (the two latter islands are immediately to the north of Flinders Island).

OLIGOTOMA LATREILLEI (Rambur).

Previously I had seen no females of this species from Australia, but recently I obtained a series from the British Museum, including a number of mature females together with a few males (coll. F. H. Taylor, 14–15.12.27, Townsville, Q.). These agree in colour and form with the females from Noumea previously examined, and are of the following dimensions: Length 7·7–9·7 mm.; head, length 1·12–1·44 mm., breadth 0·91–1·16 mm.; maximum observed number of antennal segments 22; antennal length up to 2·2 times the head-breadth. Sixteen ♀ examined. Specimens in the Macleay Museum.

Notoligotoma Davis.

Notoligotoma nitens Davis, 1936.

The following additional localities for this species are recorded: Razorback, nr. Picton, 27.9.37 (locality of 3A, Map 1); East Kangaloon, nr. Robertson, 27.9.37 (near locality of 5B, Map 1); Jooriland, Upper Burragorang, 1.12.37 (locality of 2K, Map 1); Quaamaa, 8.10.37 (locality of 3B, Map 1). At the first, third and fourth of these localities, this species was living in association with the corresponding species of *Metoligotoma*, that is, in similar situations and separated by not more than several inches from the colonies of the other genus.

These records extend the range of the species somewhat to the west, and a considerable distance to the south. Close examination of specimens from these localities, and those previously listed (Davis, 1936a, p. 248) show that there is no variation throughout the recorded range, so that in. this case no error has been introduced by the nomination of type material from a number of different localities. In the same way, no error seems to have resulted from designating as allotype of *N. hardyi* (Fried.) a female from Nyngan, N.S.W. (Davis, 1936a, p. 246), although Friederich's type males were from Perth, W.A.; the males from Western Australia and New South Wales, and also from Townsville, Q., are structurally indistinguishable.

Discussion.

Distribution.

The genus *Metoligotoma* appears to be ideal for the study of the distribution of its species with a view to tracing their natural ranges, and attempting to correlate them with causes such as geographic barriers, past and present. Both sexes are wingless and fairly sedentary. The males possess distinct systematic characters which, while having little individual variation, show marked changes from one district to another. The genus is fairly widespread, ranging at least from South Queensland to Tasmania. It is a specialized and apparently recent type. Finally, there is the consideration that its members are easily kept in culture in the laboratory, thus offering the possibility of producing hybrids under controlled conditions.

In spite of this, the results obtained from a study of the distribution of the species of *Metoligotoma* have been disappointing from the point of view of correlation with barriers or other patent causes, and no reasons can at present be advanced for specific distribution. However, certain negative results have been obtained, showing that certain apparent barriers fail to divide the genus specifically, and that such facts as altitude and geological formation are ineffectual as causes (selective or otherwise) of specific differentiation or localization in this genus.

With regard to differences in elevation of the localities of any one species, *M. pentanesiana* is found near sea-level on the Five Islands and at a height of about 2,600 feet near Robertson; *M. tasmanica tasmanica* occurs near sea-level at Bellerive, Tas., and at 1,100 feet on Mt. Nelson, Tas. Other species show a similar, if less marked, altitudinal distribution. With regard to the range of rock types on which any one species may occur, *M. reducta* occurs on Hawkesbury sandstone at Narrabeen, and on Narrabeen Shale near Otford; *M. illawarrae illawarrae* occurs on Hawkesbury sandstone at Hardy's Bay, on rocks of the Upper Coal Measures at Austinmer and of the Upper Marine Series at Huskisson, and also on igneous rock (Dapto dolerite on the two innermost of the Five Islands, and granodiorite at Burragorang). With regard to climatic changes as indicated by latitude and distance from the coast, as well as by elevation, the genus is divided into a number

of species on the New South Wales coast from north to south, and similar changes may occur proceeding from the coast inland, as in the cases of *M. collina* and *M. ingens*. This distribution might possibly be correlated with changes in temperature and humidity, but, considering all the facts, I am disinclined to believe that climate is limiting in specific distribution in this genus; at all events, three species may occur in the same locality, as at Tilba Tilba, all exposed to the same climatic conditions; and the distribution of *M. extorris* from the coast to Lake George, at least 60 miles from the sea, together with those cases of altitudinal distribution cited above, shows that one species may endure a wider range of climatic variation than that which is sometimes embraced by the entire range of two or more adjacent species. Also, all species appear to flourish in culture at Sydney.

With regard to geographic barriers, the most obvious are those which appear to be offered by large rivers and estuaries, and by expanses of sea separating coastal islands from the mainland. The nature of the genus suggests that such barriers as they exist at present would be extremely effective against migration. Collecting was therefore carried out on five coastal islands (three of the Five Islands, Brush Id., and Montague Id.) and, where possible, on both sides of the larger rivers of that part of the New South Wales coast studied. Similar collecting was carried out in Tasmania and the Furneaux Group. The discovery of *M. pentanesiana* at Robertson, and of *M. extorris* at numerous localities, on the mainland, discounts the theory put forward earlier (Davis, 1936b, p. 257) that these species were evolved, under the influence of isolation, on the most northerly of the Five Islands and on Brush Id. respectively. In addition, *M. brevispina* has been found on Montague Id. as well as at several mainland localities, and *M. illawarrae illawarrae* on the innermost two of the Five Islands, as well as at numerous mainland localities. *M. tasmanica tasmanica* occurs on North and South Bruni Id. as well as on the main island of Tasmania, while a form apparently intermediate between this subspecies and *M. tasmanica bassiana* (also from the main island of Tasmania) occurs on Flinders and Cape Barren Islands. Furthermore, the range of *M. illawarrae illawarrae* straddles such rivers as the Hawkesbury and Shoalhaven, and of *M. extorris* such rivers as the Clyde and Moruya; *M. brevispina* occurs on both sides of the Wagonga R. and the Bermagui R.; and *M. tasmanica tasmanica* on both sides of the River Derwent, Tas. In most of these cases the distribution argues against the crossing of the rivers having been effected by migration away from and around the wider estuarine portions.

At this stage a consideration of the recent changes of sea-level on the Australian coast is imperative. Daly (1934) allows a universal eustatic rise of sea-level of some 75 metres (41 fathoms) within the last 25,000 years, followed more recently (probably within the last 3,000 years) by a slight fall (some 5 metres). The 75 metres rise is correlated with the melting of the ice on the Würm (Wisconsin) glaciation of the northern hemisphere. There is fairly general agreement as to the applicability of these principles to the present case. It seems very probable that no true land movements, of sufficient importance to invalidate the arguments advanced below, have occurred in Australia within this period. This sequence, being eustatic, applies to all portions of the coastline.

Montague Id. is joined to the mainland of Australia by a submerged isthmus (running towards the Little Dromedary, where similar rocks occur to those on the island), the deepest point on which is 17 fathoms. In the same way, the most northerly of the Five Islands is separated from the mainland by a depth of only about 12 fathoms over the shallowest route. In the case of Brush Id., the deepest water separating it from Murramarang Pt. is about 3 fathoms; the innermost of

the Five Islands is separated from Red Point by about the same depth, and is joined to the other island on which *M. illawarrae illawarrae* occurs by a low, wave-swept isthmus. Obviously, Montague Id. and the most northerly of the Five Islands have been severed at some time during the last rise in sea-level (probably about 10,000 years ago), while Brush Id. and the two innermost of the Five Islands may have been separated near the end of the rise in sea-level, or by erosion at some subsequent period. All these islands have been habitable for the genus since severance. These facts fix a limit of some 10,000 years during which, even in apparently such a plastic genus as *Metoligotoma*, no specific change has occurred. These changes in sea-level have also affected the coastal rivers and estuaries in their effectiveness as barriers to migration. It follows that the genus *Metoligotoma* was probably occupying its present range in New South Wales, and differentiated into most, if not all, of its present species, at least half-way through the process of the last eustatic rise of sea-level.

The migration of the genus to Tasmania is explained in the same way. Tasmania is separated from Victoria by a submerged isthmus* running through the Kent and Furneaux Groups (Map 3), the deepest water along which is 32 fathoms, some of which is undoubtedly due to marine and submarine erosion at and since submergence; the tide-rips in this sector are amongst the worst on the Australian coast. The genus *Metoligotoma* is recorded from Flinders Id., Cape Barren Id. (south of Flinders Id.) and over a large area of Tasmania. Over the shallowest route, the deepest water from Flinders Id. to Cape Barren Id. is 4 fathoms, from Cape Barren Id. to Tasmania 18 fathoms. There can be no doubt that *Metoligotoma* migrated across the Bassian Isthmus (the Order is of northern derivation) during a period of low sea-level. The same applies to *Oligotoma gurneyi gurneyi*, recorded from Tasmania, Victoria and New South Wales, and from Flinders Id., and two islands north of it (East Sister Id., West Sister Id.), which are too small to possess sufficiently sheltered situations for *Metoligotoma*. Collection and study of *Metoligotoma* from Southern Victoria and the Kent Group should strengthen the above hypothesis.

The records of *M. tasmanica tasmanica* on North and South Bruni Id. throw light on the past climate of Tasmania. North and South Bruni are joined by a low isthmus of sand-dunes, and were almost certainly separate islands 3,000 years ago. The shallowest connection to the main island of Tasmania runs from the extreme south of North Bruni (Soldier's Point) and the extreme north of South Bruni Id. (Simpson's Pt.), and is at the deepest 6½ fathoms. There are also submerged ridges from the north end of North Bruni Id. (Denne's Pt.) to both the north and south side of the Derwent Estuary, each reaching 9 fathoms at the neck. While it is impossible to say by which route or routes the genus reached its present localities (Map 2, 1C, 1D), it is evident that it must have reached as far south as 43° S. latitude before the connection to Bruni Id. was severed. It must be remembered that the locality on S. Bruni Id. (Map 2, 1D), at 43° 16′ S. latitude, is the farthest southern record for the genus, which is absent from the colder and wetter parts of Tasmania (Map 2, XA–XK); the record is, with one exception (*Embia taurica* Kus. from the Crimea, 44° 20′ N. latitude: see Kusnezov, 1904), the highest latitude for the Order. These facts suggest that Tasmania has possessed a climate no more extreme than the present during the last 6,000 years. Correlations of the Tasmanian glaciations with those of the northern hemisphere, or absolute estimates of their age, are at present vague (Lewis, 1933). These

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* For previous references to the Bassian Isthmus see Hedley (1903) and Tillyard (1913).

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facts, together with others which biologists may from time to time adduce, may help in the estimation of these ages. It is probable, for instance, that the last (Margaret) glaciation of Tasmania pre-dated the Würm–Wisconsin glaciation, which was, according to the above interpretation, still in force when the genus *Metoligotoma* reached Bruni Id.

There is no absolute proof that the species of *Metoligotoma* did not take up their present distribution at an earlier period of low sea-level. Facts against this are (i) that the genus is specialized and apparently recent, with species whose limited distribution argues of their recency; (ii) with reference to the Tasmanian migration, it is putting the Margaret glaciation too far back to postulate the entry of *Metoligotoma* to its Tasmanian localities at an earlier low sea-level. The migration to Tasmania of *Oligotoma gurneyi gurneyi* is placed as coincident with that of *Metoligotoma*, for climatic reasons. It is unlikely that *Metoligotoma* will be found on King Island. *M. tasmanica biloba*, from the western part of the north coast of Tasmania, is by its structure derivable from the other subspecies, and probably fairly recent in origin. It seems to agree with the 'Age and Area' Principle, being structurally more advanced and geographically more limited than *M. tasmanica tasmanica*. The McCoy Society Expedition (1937–8) to King Island secured no Embioptera, although a special search was made.

The limits of the genus *Metoligotoma*, as opposed to those of each of its species, are probably in part determined by climatic factors. Situations in which the genus occurs are neither very wet nor very dry. Its apparent absence from the drier parts of New South Wales can be satisfactorily explained climatically, but certain apparently suitable situations in the more westerly parts of the Blue Mts. (Hartley, Hampton, Oberon, etc.) have been searched without success. The genus is apparently absent from this region, but no explanation can be given other than

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2H, at Hardy's Bay, Broken Bay; 2J, at Red Point, near Port Kembla; 2K, at Jooriland, Upper Burragorang.

2′.—*M. illawarrae septentrionis*, nov.: 2′A, at Elanora, near Narrabeen; 2′B, at Yellow Rock, near Springwood; 2′C, at Jooriland, Upper Burragorang (2K-2′C indicates that intermediates between 2 and 2′ also occur).

2″.—*M. illawarrae telocera*, nov.: 2″A, Cooper Park, Bellevue Hill, Sydney.

3.—*M. collina collina*, nov.: 3A, at Razorback, near Picton; 3B, at the Gib, near Mittagong.

3′.—*M. collina exigua*, nov.: 3′A, at Wentworth Falls.

4.—*M. ingens* Davis: 4A, at Black Mtn., Canberra (A.C.T.).

5.—*M. pentanesiana* Davis: 5A, on most northerly of the Five Islands; 5B, at the top of Macquarie Pass, near Robertson.

6.—*M. extorris* Davis: 6A, on Brush Id.; 6B, at Ulladulla; 6C, on hills west of Lake George; 6D, at Bateman's Bay, north of Clyde R.; 6E, at Deep Ck., near Mogo; 6F, at Granite Quarry, north of Moruya R.; 6G, at Gundary, near Moruya; 6H, south of Moruya R., between Moruya and Moruya Heads; 6J, south of Moruya R., near Moruya Heads.

7.—*M. intermedia*, nov.: 7A, at Tomerong, near Nowra; 7B, on north side of Parma Ck., near Nowra; 7C, at Sassafras.

8.—*M. anomala*, nov.: 8A, at Bateman's Bay, north of Clyde R.

9.—*M. brevispina*, nov.: 9A, at South Bermagui; 9B, on Montague Id.; 9C, at Narooma, south of Wagonga R.; 9D, at Narooma, north of Wagonga R.; 9E, on slopes of the Little Dromedary, Central Tilba.

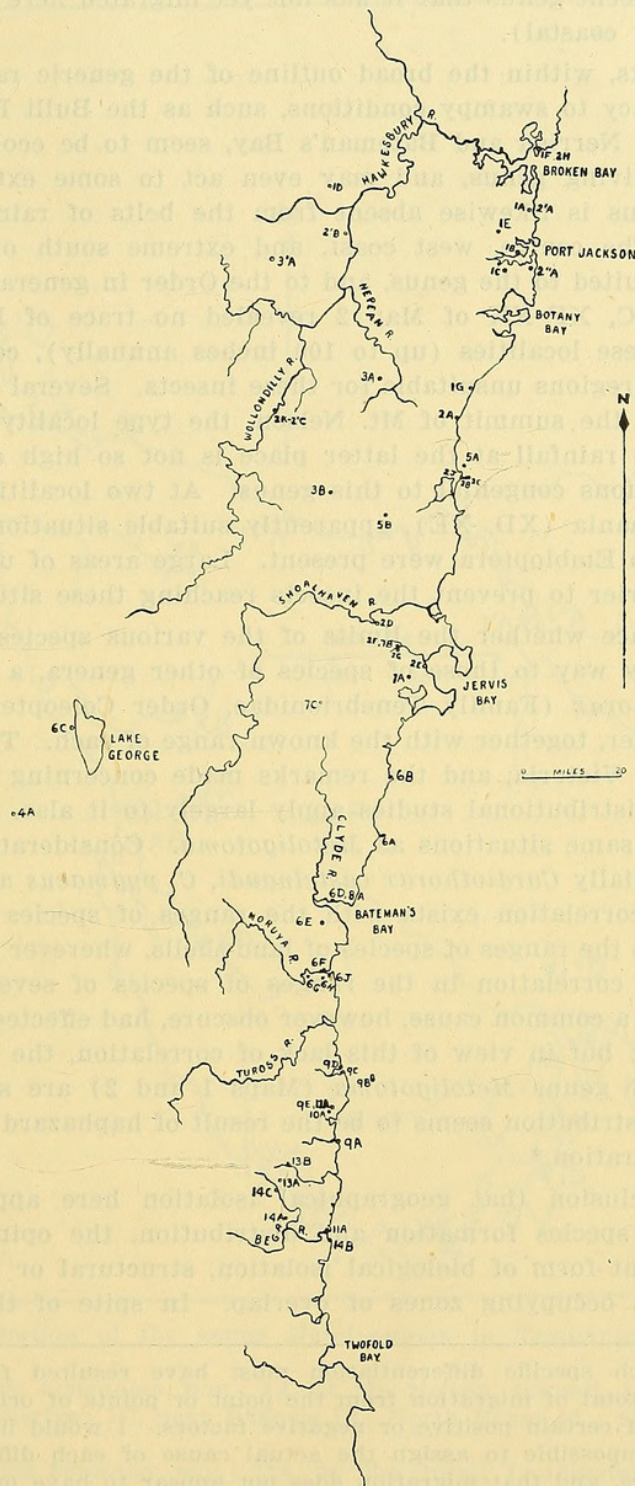10.—*M. convergens*, nov.: 10A, at Tilba Tilba.

11.—*M. bidens*, nov.: 11A, north of Bega R., near mouth.

12.—*M. pugionifer*, nov.: 12A, on slopes of the Little Dromedary, Central Tilba.

13.—*M. minima*, nov.: 13A, near Brogo (¼ mile north-east of Brogo); 13B, at Quaamaa, north of Dry River.

14.—*M. begae*, nov.: 14A, near Bega (2 miles north of Bega); 14B, at Tathra; 14C, near Brogo (2 miles south of Brogo Bridge).

N.B.—"A" represents type locality in each case.

Map 1.—Central and South Coastal districts and Dividing Range, New South Wales, to show distribution of species of *Metoligotoma*.

1.—*M. reducta* Davis: 1A, at Elanora, near Narrabeen; 1B, at Mosman; 1C, at Sydney University; 1D, at Kurrajong Heights; 1E, at Lindfield; 1F, at Hardy's Bay, Broken Bay; 1G, at Otford.

2.—*M. illawarrae illawarrae*, nov.: 2A, at Austinmer; 2B, on innermost of Five Islands; 2C, on second of the Five Islands; 2D, at Bamarang, near Nowra; 2E, at Huskisson; 2F, on north side of Parma Ck., near Nowra; 2G, on south side of Parma Ck.;

that it is such a recent genus that it has not yet migrated here from its point of origin (presumably coastal).

Certain districts, within the broad outline of the generic range, where there is a general tendency to swampy conditions, such as the Bulli Pass area and the mountains between Nerriga and Bateman's Bay, seem to be ecologically unsuited to such a ground-living genus, and may even act to some extent as ecological barriers. The genus is likewise absent from the belts of rain-forest along the coastal district. The centre, west coast, and extreme south of Tasmania seem to be similarly unsuited to the genus, and to the Order in general. Careful search at localities XA–XC, XF–XK of Map 2 revealed no trace of Embioptera. The high rainfall in these localities (up to 100 inches annually), combined with the cold, renders these regions unsuitable for these insects. Several of these localities are no colder than the summit of Mt. Nelson, the type locality of *M. tasmanica tasmanica*; but the rainfall at the latter place is not so high as to prevent the formation of situations congenial to this genus. At two localities on the central west coast of Tasmania (XD, XE), apparently suitable situations were found on shrub-dunes, but no Embioptera were present. Large areas of unsuitable country would act as a barrier to prevent the insects reaching these situations.

In order to trace whether the limits of the various species of *Metoligotoma* were related in any way to those of species of other genera, a list of species of the genus *Cardiothorax* (Family Tenebrionidae, Order Coleoptera) was obtained from Mr. H. J. Carter, together with the known range of each. This genus extends from Cape York to Victoria, and the remarks made concerning the suitability of *Metoligotoma* for distributional studies apply largely to it also. Its members are often found in the same situations as *Metoligotoma*. Consideration of the ranges of its species, especially *Cardiothorax castelnaudi*, *C. pygmaeus* and *C. walcknaeri*, indicates that no correlation exists with the ranges of species of *Metoligotoma*. The same applies to the ranges of species of land-shells, wherever sufficient data are available. A close correlation in the ranges of species of several genera might have indicated that a common cause, however obscure, had effected specific distribution in each genus; but in view of this lack of correlation, the details of specific distribution for the genus *Metoligotoma* (Maps 1 and 2) are submitted without explanation; the distribution seems to be the result of haphazard species-formation and haphazard migration.*

With the conclusion that geographical isolation here appears to play no explicable part in species formation and distribution, the opinion may also be given that no patent form of biological isolation, structural or temporal, appears to separate species occupying zones of overlap. In spite of the variety of the

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* Of course, each specific differentiation must have resulted from some efficient cause, and the sum total of migration from the point or points of origin of each species must be the result of certain positive or negative factors. I would imply that the facts indicate that it is impossible to assign the actual cause of each differentiation, or the time of its occurrence, and that migration does not appear to have proceeded to a point where each species has its range limited by environmental factors, but rather has been governed by incidental causes which it is impossible to trace, producing a distribution which appears to be haphazard and which is almost certainly not static or final.

Davey; XJ, New Harbour; XK, Recherche Bay. Except at XD and XE, situations favourable to the genus do not occur at the above localities, the whole of the area west of the line XA–XJ probably being without members of the Order, for climatic reasons. At XD and XE restricted situations, apparently suitable, are found, but no members of the genus, probably on account of the barrier of unsuitable country between.
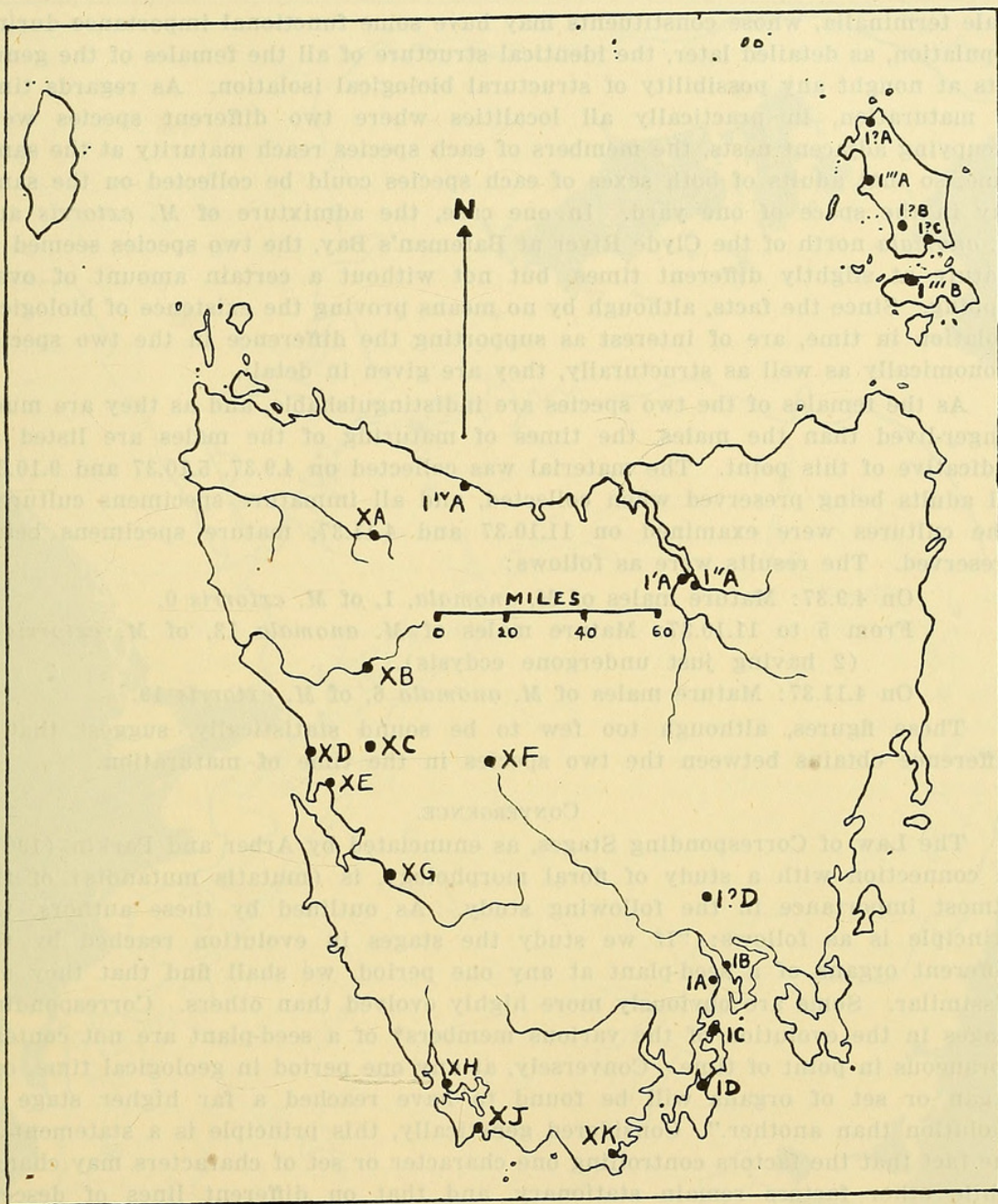
Map 2.—Distribution of the genus *Metoligotoma* in Tasmania and the Furneaux Group.

1.—*M. tasmanica tasmanica*, nov.: 1A, at Mt. Nelson, summit, 1,100′ (also on slopes at 400′); 1B, at Bellerive; 1C, near Denne's Pt., North Bruni Id.; 1D, at Simpson's Bay, S. Bruni Id.

1^i.—*M. tasmanica bassiana*, nov.: 1^{i}A, at The Gorge, Launceston.

1^{ii}–1^{iii}.—Types showing characters intermediate between 1 and 1^i: 1^{ii}A, at Punch Bowl, near Launceston; 1^{iii}A, at Emita, Flinders Id.; 1^{iii}B, at Big River, Cape Barren Id.

1^{iv}.—*M. tasmanica biloba*, nov.: 1^{iv}A, at Blythe R., near Burnie.

1?.—*M.* sp. indet. (no mature males collected): 1?A, at Palana, Flinders Id.; 1?B, on slopes of Mt. Strzelecki, Flinders Id., at 1,500′; 1?C, at Lady Barron, Flinders Id.;* 1?D, at Pulpit Rock, Bagdad Valley. (A–C are probably as from Emita, Flinders Id.; D, probably as from Mt. Nelson-Bellerive.)

X.—Localities where *Metoligotoma* does not occur: XA, Hellyer Gorge; XB, Pieman R., near Rosebery; XC, Lake Margaret, near Queenstown; XD, Henty River; XE, Strahan; XF, Lake St. Clair; XG, Eagle Ck., Gordon River; XH, Roaring Beach, Port

* See footnote, p. 248.

male terminalia, whose constituents may have some functional importance during copulation, as detailed later, the identical structure of all the females of the genus sets at nought any possibility of structural biological isolation. As regards time of maturation, in practically all localities where two different species were occupying adjacent nests, the members of each species reach maturity at the same time, so that adults of both sexes of each species could be collected on the same day in the space of one yard. In one case, the admixture of *M. extorris* and *M. anomala* north of the Clyde River at Bateman's Bay, the two species seemed to mature at slightly different times, but not without a certain amount of over-lapping. Since the facts, although by no means proving the existence of biological isolation in time, are of interest as supporting the difference in the two species bionomically as well as structurally, they are given in detail.

As the females of the two species are indistinguishable, and as they are much longer-lived than the males, the times of maturing of the males are listed as indicative of this point. The material was collected on 4.9.37, 5.10.37 and 9.10.37, all adults being preserved when collected, and all immature specimens cultured. The cultures were examined on 11.10.37 and 4.11.37, mature specimens being preserved. The results were as follows:

On 4.9.37: Mature males of *M. anomala*, 1, of *M. extorris* 0.

From 5 to 11.10.37: Mature males of *M. anomala* 13, of *M. extorris* 5 (2 having just undergone ecdysis).

On 4.11.37: Mature males of *M. anomala* 6, of *M. extorris* 19.

These figures, although too few to be sound statistically, suggest that a difference obtains between the two species in the time of maturation.

CONVERGENCE.

The Law of Corresponding Stages, as enunciated by Arber and Parkin (1907) in connection with a study of floral morphology, is (mutatis mutandis) of the utmost importance in the following study. As outlined by these authors, the principle is as follows: "If we study the stages in evolution reached by the different organs of a seed-plant at any one period, we shall find that they are dissimilar. Some are obviously more highly evolved than others. Corresponding stages in the evolution of the various members* of a seed-plant are not contemporaneous in point of time. Conversely, at any one period in geological time, one organ or set of organs will be found to have reached a far higher stage of evolution than another." Considered genetically, this principle is a statement of the fact that the factors controlling one character or set of characters may change while other factors remain stationary, and that on different lines of descent varying factors undergo changes at different times and in different sequence. Application of this principle to a study of convergence in the Order Embioptera has proved very helpful, as indeed it must in any group.

Figure 120 represents a scheme for the phylogeny of certain selected species of Embioptera. The end of each sequence represents a present-day form. Where an existing form has been placed on the direct ancestral line of another form, it is implied that the hypothetical ancestor resembled the existing form named—at least for those characters here dealt with—and that the existing type has changed little in these characters from this ancestor.

The following characters are considered from an evolutionary viewpoint: wings, first abdominal sternite, and characters of the male terminalia—left and right cerci, left and right hemitergites of the tenth abdominal segment and their

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* Organs.—C.D.
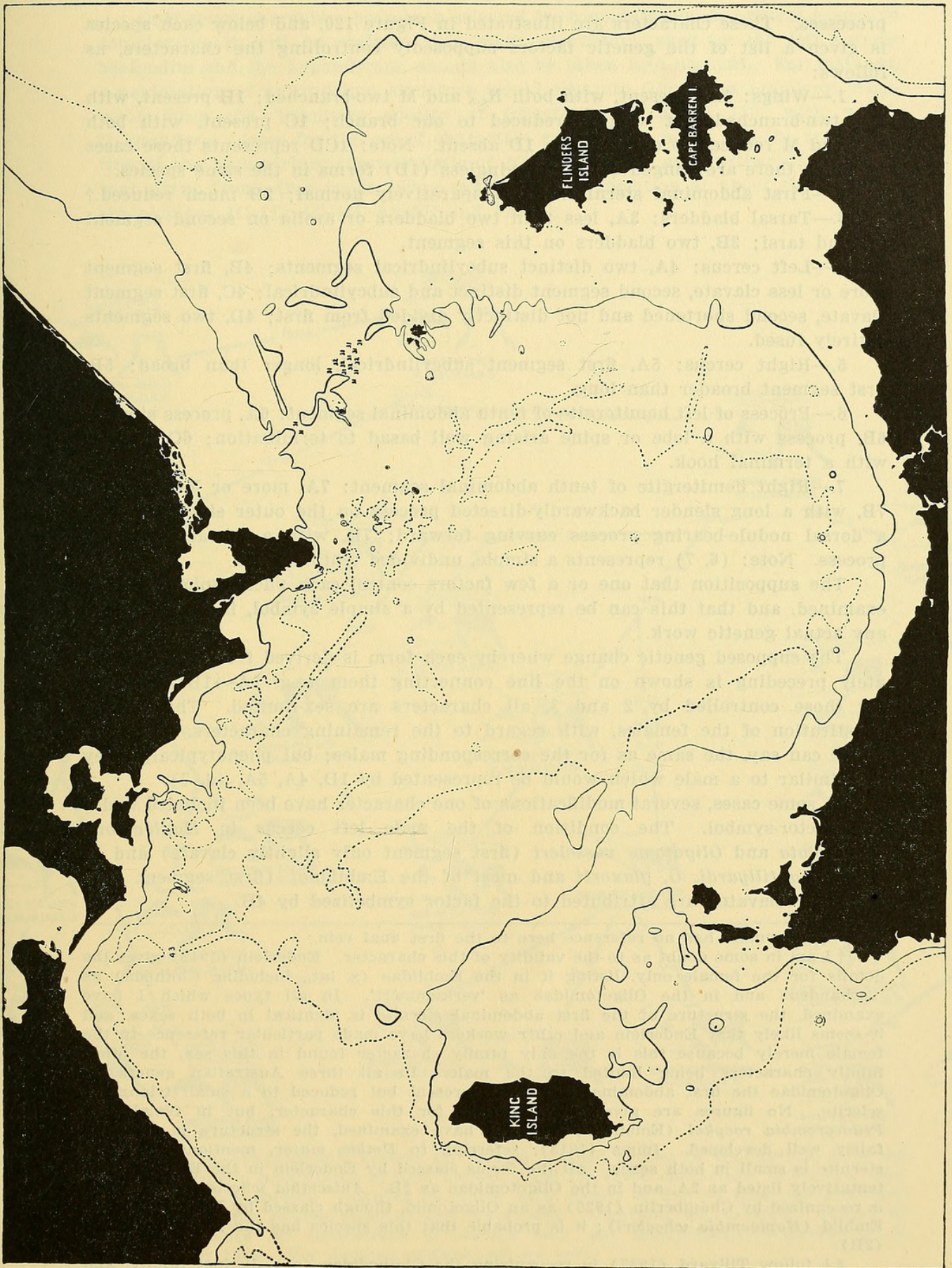
Map 3.—Bass Strait, with 30- and 40-fathom isobaths (entire and broken lines respectively). Soundings in excess of 30 fathoms on the neck of the former 'Bassian Isthmus' (31, 32 fathoms) also indicated. Approximately 40 miles to the inch.

processes. These characters are illustrated in Figure 120, and below each species is given a list of the genetic factors supposedly controlling the characters, as follows:

1.—Wings: 1A* present, with both R_{4+5} and M two-branched; 1B present, with R_{4+5} two-branched, but with M reduced to one branch; 1C present, with both R_{4+5} and M reduced to one branch; 1D absent. Note: 1CD represents those cases in which there are winged (1C) and wingless (1D) forms in the same species.

2.—First abdominal sternite: 2A comparatively normal; 2B much reduced.†

3.—Tarsal bladders: 3A, less than two bladders or arolia on second segment of hind tarsi; 3B, two bladders on this segment.

4.—Left cercus: 4A, two distinct subcylindrical segments; 4B, first segment more or less clavate, second segment distinct and subcylindrical; 4C, first segment clavate, second shortened and not distinctly divided from first; 4D, two segments entirely fused.

5.—Right cercus: 5A, first segment subcylindrical, longer than broad; 5B, first segment broader than long.

6.—Process of left hemitergite of tenth abdominal segment: 6A, process simple; 6B, process with a lobe or spine arising well basad to termination; 6C, process with a terminal hook.

7.—Right hemitergite of tenth abdominal segment: 7A, more or less simple; 7B, with a long slender backwardly-directed process on the outer side; 7C, with a dorsal nodule-bearing process curving forward; 7D, with a dorsal foliaceous process. Note: (6, 7) represents a simple, undivided tenth tergite.

The supposition that one or a few factors control each phenotypic character examined, and that this can be represented by a simple symbol, is not based on any actual genetic work.

The supposed genetic change whereby each form is derived from the immediately preceding is shown on the line connecting them (e.g. 1A→1B). Except for those controlled by 2 and 3, all characters are sex-limited. The genetic constitution of the females, with regard to the remaining characters, is, as far as we can say, the same as for the corresponding males; but phenotypically they are similar to a male which would be represented by 1D, 4A, 5A, (6, 7).

In some cases, several modifications of one character have been included under one factor-symbol. The condition of the male left cercus in *Haploembia*, *Monotylota* and *Oligotoma vosseleri* (first segment only slightly clavate) and in *Oligotoma tillyardi*, *O. glauerti* and most of the Embiidae‡ (first segment very markedly clavate) are attributed to the factor symbolized by 4B.

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* This symbol has no reference here to the first anal vein.

† I am in some doubt as to the validity of this character. Enderlein (1912) gives the details for the female only, listing it in the Embiidae (s. lat., including Clothoda) as 'vorhanden', and in the Oligotomidae as 'verkümmert'. In all types which I have examined, the structure of the first abdominal sternite is identical in both sexes, and it seems likely that Enderlein and other workers have made particular reference to the female merely because this is the only family character found in this sex, the other family characters being limited to the male. In all three Australian genera of Oligotomidae the first abdominal sternite is present but reduced to a small triangular sclerite. No figures are given by Enderlein for this character, but in females of *Ptilocerembia roepkei* (Embiidae) which I have examined, the structure is certainly fairly well developed. Imms (1913), referring to *Embia major*, mentions that this sternite is small in both sexes. All the forms classed by Enderlein in the Embiidae are tentatively listed as 2A, and in the Oligotomidae as 2B. *Anisembia wheeleri* (Melander) is recognized by Chamberlin (1923) as an Oligotomid, though classed by Enderlein as an Embiid (*Haploembia wheeleri*); it is probable that this species has the sternite reduced (2B).

‡ I follow Tillyard (1937) in recognizing the Clothodidae as a distinct family, and use the term Embiidae in the strict sense. Enderlein (1912) recognizes the Clothodinae as a subfamily only, within the family Embiidae.

Only seven characters have been selected for consideration, to prevent excessive complexity; it will be realized that other characters, such as the left cercus-basipodite and the hypandrium, should also be taken into account. For instance, consideration of hypandrium structure would separate *Oligotoma saundersi* Westwood from the 'primitive species of *Oligotoma*' of figure 120, with which *O. saundersi* agrees for the set of characters enumerated here; and the specialization of the hypandrium characteristic of *Metoligotoma* would further differentiate that genus from other types, being capable of interpolation at about the times of the changes 1C–1D, 4C–4D, 5A–5B and 7A–7D.
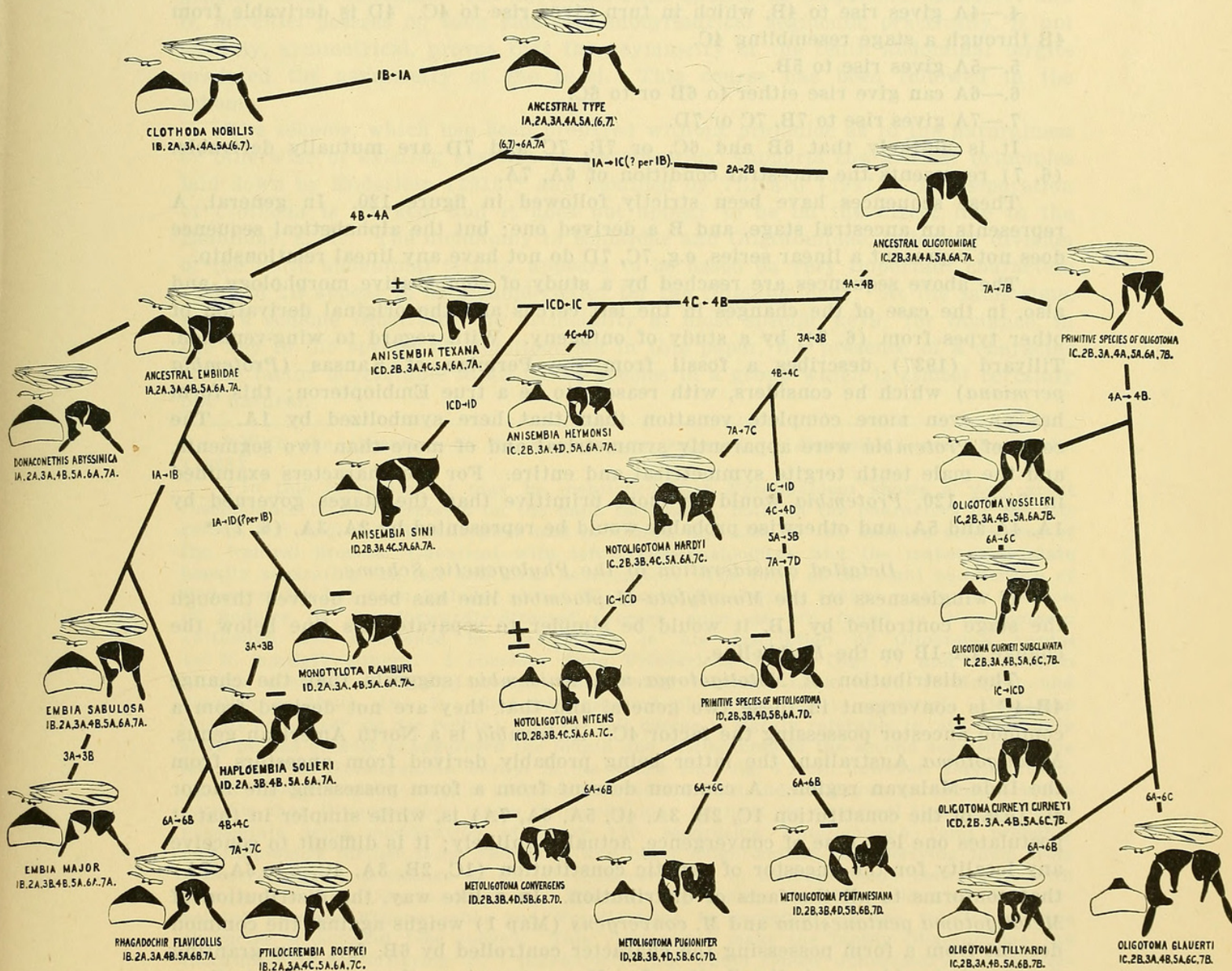
Fig. 120.—Phylogenetic scheme for certain selected species of Embioptera, with the assumed genetic constitution of each species listed for seven characters, which are illustrated for each species. Changes by which each species is derived from the preceding indicated on line joining ancestor and descendant. Diagrams not to scale; lengths of connecting lines for convenience in spacing only, not proportional to divergence in structure or time. For detailed explanation see text.

The scheme has been drawn up in the simplest possible way; convergence has not been invoked unless the opposite course does violence to any known facts. Whether the simplest scheme is necessarily correct depends on one's opinions on the frequency of convergence; this is discussed later.

Phylogenetic sequence.

1.—1A gives rise to 1B; 1C is derived from 1A, probably through 1B; 1D is derivable from 1A, 1B, or 1C; 1CD represents a stage where some individuals have undergone the change 1C–1D, others remained at 1C.

2.—2A gives rise to 2B.

3.—3A gives rise to 3B.

4.—4A gives rise to 4B, which in turn gives rise to 4C. 4D is derivable from 4B through a stage resembling 4C.

5.—5A gives rise to 5B.

6.—6A can give rise either to 6B or to 6C.

7.—7A gives rise to 7B, 7C or 7D.

It is unlikely that 6B and 6C, or 7B, 7C and 7D are mutually derivable. (6, 7) represents the ancestral condition of 6A, 7A.

These sequences have been strictly followed in figure 120. In general, A represents an ancestral stage, and B a derived one; but the alphabetical sequence does not represent a linear series, e.g. 7C, 7D do not have any lineal relationship.

The above sequences are reached by a study of comparative morphology, and also, in the case of the changes in the left cercus and the original derivation of other types from (6, 7), by a study of ontogeny. With regard to wing-venation, Tillyard (1937) describes a fossil from the Permian of Kansas (*Protembia permiana*) which he considers, with reason, to be a true Embiopteron; this form has an even more complete venation than that here symbolized by 1A. The cerci of *Protembia* were apparently symmetrical and of more than two segments, and the male tenth tergite symmetrical and entire. For the characters examined in figure 120, *Protembia* would be more primitive than the stages governed by 1A, 4A and 5A, and otherwise probably would be represented by 2A, 3A, (6, 7).*

Detailed consideration of the Phylogenetic Scheme.

If winglessness on the *Monotylota–Haploembia* line has been derived through the stage controlled by 1B, it would be simpler to separate this line below the change 1A–1B on the *Embia*-line.

The distribution of *Notoligotoma* and *Anisembia* suggests that the change 4B–4C is convergent in these two genera, and that they are not derived from a common ancestor possessing the factor 4C. *Anisembia* is a North American genus, *Notoligotoma* Australian, the latter being probably derived from ancestors from the Indo–Malayan region. A common descent from a form possessing the factor 4C (e.g. of the constitution 1C, 2B, 3A, 4C, 5A, 6A, 7A) is, while simpler in that it postulates one less case of convergence, actually unlikely; it is difficult to conceive any locality for the ancestor of genetic constitution (1C, 2B, 3A, 4C, 5A, 6A, 7A) that conforms to all the facts of distribution. In a like way, the distribution of *Metoligotoma pentanesiana* and *M. convergens* (Map 1) weighs against the common descent from a form possessing the character controlled by 6B, for, even granting a somewhat wider past distribution for *M. pentanesiana* than at present, there would be a considerable intermediate zone populated by forms represented for this character by the factor 6A.

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* Zalessky (1937) has meagrely described a similar type (*Tillyardembia biarmica*) from the Upper Permian of Russia.

Oligotoma vosseleri has been placed away from the direct line to *O. glauerti* and *O. tillyardi*, and on the ancestry of *O. gurneyi*, on account of its mandible structure (see Davis, 1936a, p. 233), which, as in *O. gurneyi*, is more specialized than in *O. glauerti* and *O. tillyardi*.

Embia major differs from it congeners in the presence of an extra tarsal bladder (fide Imms, 1913, p. 173). In those cases where no mention of tarsal bladders has been made by Enderlein (1912)—e.g. *Rhagadochir*—it is assumed that the normal state obtains, two being exceptional, and as such certain to be mentioned.

Tillyard (1937, p. 249) states that the cerci are asymmetrical in all recent genera except *Clothoda*. The fact that such species as *Oligotoma saundersi* and *O. latreillei* possess on each side two subcylindrical segments, practically, if not entirely, symmetrical, proves that the asymmetry of the tenth abdominal tergite predated the asymmetry of the cerci. This course has been followed in the scheme.

The scheme, which has been prepared without prejudice as to the naturalness or otherwise of existing systems of classification, supports the general principles laid down by Enderlein (1912)* and modified by Tillyard (1937). The separation of *Clothoda* is marked, and it does not appear to be on the direct line to the Embiidae, s. str. The dichotomy to Embiidae and Oligotomidae, following division of the tenth abdominal tergite, appears to be based on very important characters (1C and 2B appear to be monophyletic† for the Oligotomidae). At the same time, such a scheme illustrates the artificiality of most specific keys; for instance, in the key to the species of *Metoligotoma* in this paper, the presence of a character whose factor is referable to 6B places species in a group which is almost certainly not natural.

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* With the exception of the species now referred to *Anisembia*; see Chamberlin (1923).

† In this connection it may be mentioned that *Notoligotoma* shows a very great resemblance to *Ptilocerembia* on the male terminalia, both on the characters of the left cercus, left and right hemitergites and processes, and also on the unlisted characters of the 'ventral process' (identical with left cercus-basipodite) and the trapezoidal plate basally separating the left and right hemitergites. The form of the right hemitergite of *Ptilocerembia* has been included under 7C, though Friederichs (1923) makes no mention of nodules on the forwardly-directed process, such as are found in *Notoligotoma* (although not mentioned by Friederichs in his description of *Oligotoma hardyi* (= *N. hardyi*) either). I consider from Friederichs' figure (fig. 7) and description (Links (Cercus) 1. Glied hinten wulstförmig verdickt, nach innen verlängert und daselbst gezähnt. Das 2. Glied ist kurz und plump an das 1. angesetzt. Der linke Cercus ist kürzer als der rechte) that the left cercus is rightly referable to '4C', especially since he has greatly exaggerated the length and distinctness of the second segment of the left cercus of *Notoligotoma hardyi* in his figure (l.c., fig. 1; cf., however, Davis, 1936a, fig. 8). Since *Notoligotoma* is probably derived from an Indo-Malayan ancestor, it seems possible that *Ptilocerembia* (from Sumatra) may be near its ancestral line; this would necessitate some modification of figure 120, separating *Notoligotoma* (and probably *Metoligotoma*) further from *Anisembia* and other Oligotomidae, and deriving them from *Ptilocerembia* by a change of 1B-1C (*Ptilocerembia* to *Notoligotoma*) convergent with that in the true Oligotomid stock. Whether the change 2A-2B would also be interpolated between *Ptilocerembia* and *Notoligotoma* is uncertain, as the validity of this character is doubtful (see above). This view would make the family Oligotomidae (as recognized by the criterion '1C') polyphyletic, but would render unnecessary the convergence of 4B-4C, 7A-7C, postulated in figure 120 for *Ptilocerembia* and *Notoligotoma*. With reference to the polyphyly of the family Oligotomidae (as recognized by 1C) demanded by this course, it is to be noted that the venation of *Notoligotoma*, though similar in disposition, is more strongly developed, that is, less obsolescent, than in *Oligotoma*; this supports the view that *Notoligotoma* is derived, not from a form near *Oligotoma*, but by an independent loss of R_5 as present in the Embiidae.

Consideration of convergence in characters dealt with in figure 120.

1.—Convergence by loss is of greater frequency than convergence by acquisition. Loss of the second branch of M is convergent in the development of *Clothoda* from the ancestral type and in the development of the *Embia*-line from primitive Embiidae, and, if 1C is derived from 1A by way of 1B, on the Oligotomid line also. Loss of wings in some (1CD) or all (1D) individuals of a species is convergent in the *Monotylota–Haploembia* line, *Anisembia texana* and *A. wheeleri*, *Notoligotoma nitens*, *Oligotoma gurneyi gurneyi*, and the line leading to *Metoligotoma*.

2.—Apparently no convergence.

3.—Development of an extra tarsal bladder is convergent in *Embia major*, *Haploembia*, and the line leading to *Notoligotoma* and *Metoligotoma*.

4.—The change 4A–4B occurs in the development of primitive Embiidae, the development of the *Anisembia–Notoligotoma–Metoligotoma* line from primitive Oligotomidae, and the development of the majority of species of *Oligotoma* from the primitive species of this genus.

The change 4B–4C* occurs convergently in *Ptilocerembia* (not very completely) and in *Notoligotoma* and *Anisembia*, probably separately in the latter. The development of 4D is convergent in *Anisembia heymonsi* (End.) and the genus *Metoligotoma*.

5.—The change 5A–5B appears to be monophyletic.

6.—The type of factor classed as 6B arose convergently from 6A in *Rhagadochir*, *Oligotoma tillyardi* and *Metoligotoma pentanesiana* (see Davis, 1936b, p. 257), and probably separately in *M. convergens* (see above).

The type of structure classified as 6C arose convergently in *Oligotoma glauerti* (somewhat modified), *O. gurneyi* and *Metoligotoma pugionifer*. The change 7A–7C appears to be convergent in *Ptilocerembia* and *Notoligotoma*.† The change 7A–7B appears to be monophyletic, emphasizing the naturalness of *Oligotoma*, s. str., as defined in Part i (p. 231). The change 7A–7D appears to be monophyletic, as with 5A–5B; this, together with such additional characters as the hypandrium, emphasizes the naturalness of the genus *Metoligotoma*.

Convergence and Determinism.

Below is advanced a deterministic theory of convergence of homologous structures,‡ involving the Law of Corresponding Stages, which seems to explain naturally even such outstanding cases of convergence as the fore limbs, etc., of Mantidae and Mantispidae, members of different major groups of Pterygota.

Whatever cause one assigns to evolutionary changes—whether it be mutation, orthogenesis, somatic induction, non-adaptive variation due to chemical or physical stimuli in the environment—most workers will agree that every genotypic change has some cause, however obscure, and that, if similar causes act on similar genetic organizations under similar conditions, similar effects will be produced, which

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* According to figure 120 ; but see footnote on page 267.

† According to fig. 120 ; but see footnote on p. 267.

‡ Convergence of homologous structures may appear a contradiction in terms to those who reserve the term 'homologue' for a structure necessarily present in the common ancestor of types compared. The use of 'homologous' in this paper implies, not common descent from a type posessing the structure, but a closer correspondence than would be conveyed by the term 'analogous'; the correspondence is so close that it is assumed that a similar genetic constitution is responsible for the 'homologues'. The term 'convergence' in this paper is applied to the phenomenon classed by Osborn (1905) as parallelism, not convergence.

will be manifested by similar characters. This argument can be applied to the gene or genes controlling a certain character, no matter what stages have been reached in the evolutionary sequence by the genes controlling other characters.

Considering the factor (or factors) represented by 6A in figure 120, similar causes should produce the same changes, and, except for the possibility of modifying effects of other genes, develop the same characters, no matter what be the constitution of the genes controlling the other characters considered. Thus the character represented by 6B arises convergently in association with quite different combinations of other characters in *Rhagadochir*, *Oligotoma tillyardi* and *Metoligotoma pentanesiana*, merely by the normal working of efficient causation. This argument can be applied to all cases of convergence of homologous structures.

An objection to the above may be put thus: 'Why are not the characters represented by, say, 6B, absolutely similar in all three types?' This does not seem to damage the validity of the theory in general, since it is probable that (1) the change 6A–6B may not be in one step; not all the required steps may have been taken in the same direction in each case, only the causes for certain of the steps having recurred in all cases: the variety of structures included under 6A itself (as under 4B, 7A, etc.) is met by this consideration; (2) there may have been the same cause and effect (or sequence of causes and effects) for the gene primarily concerned with the character 6 in each case, but modifying factors affecting the character 6 may be present on other factors, possibly on some of the factors listed (1, 2, 3, 4, 5, 7); or (3) environmental differences might cause slight phenotypic differences in the various types possessing the identical factor 6B. (3) does not apply to the Embioptera, but must be taken into consideration in some groups. With reference to this objection, however, the closer the convergence, and the more surprising it may otherwise appear, the more directly is it explained by the present theory. In the case of recurrence of identical non-atavistic colour-patterns in different families or genera of Rhopalocera, which may or may not have a functional significance mimetically, the same consideration holds; and the closer the types, the greater the likelihood of identical effects being produced, since less possibility has occurred for the primary factor in the two types to undergo any steps in divergent directions, in the short time since the dichotomy of the two types, before the common cause for the convergent change came into play; and less possibility has been present for the development of divergent modifying factors.

It may be said now that the true phylogeny of the types studied may actually be anything between that given in figure 120 and a scheme in which the end-type of each line would be placed at the distal end of a separate radius, the centre of these radii representing a common ancestor which might not even possess the ordinal characters of the Embioptera. This latter seems to be an extreme view, but some intermediate probably obtains.

In general, convergence of characters of some functional use is likely to be noticed more frequently than that of purposeless or harmful characters, not because it would occur more frequently, but because it would be more likely to be selected and preserved. Convergence by loss is more likely to occur than convergence by acquisition, since the causes of loss of a gene or the rendering of it non-functional appear more likely to recur frequently than causes adding to the complexity of the genetic constitution. These two views are supported by actual observation in numerous groups of animals and plants.

The present theory allows of the prediction of the structure of species which may be discovered in future. Actually, the species *Oligotoma approximans*, the specimens of which were received after the theory was fully developed, combines
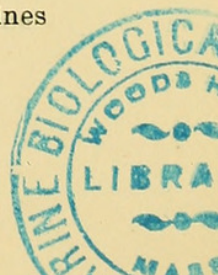
characters of the right hemitergite of *O. gurneyi gurneyi*, the left cercus of *O. gurneyi centralis*, the mandibles of *O. glauerti*, the hypandrium and left cercus-basipodite similar to *O. tillyardi*, the left hemitergite of *Metoligotoma minima*, and wings, legs, first abdominal sternite, etc., as in all species of *Oligotoma*.

The theory advanced is also applicable to a consideration of whether any species is derived from a single individual which underwent the change differentiating it from its immediately ancestral species, or whether this change occurred independently in a number of individuals. The independent development of the new specific character in different individuals would correspond to cases of convergence. On the arguments applied to figure 120, it seems not unlikely that the character would be independently derived on more than one occasion. This view is supported by the recurrence of certain mutations in *Drosophila*.

STRUCTURE AND FUNCTION.

Although variations in structure of the terminalia of the genus *Metoligotoma*, and indeed of the Order in general, often appear at first sight to be orthogenetic in origin, closer examination frequently reveals a functional use for certain organs, although in annecent species slightly different modifications may perform the same purpose apparently with equal efficiency. When the mode of copulation is considered (cf. Friederichs, 1934, figs. 9, 10), the necessity for efficient copulatory appendages is realized, and any added efficiency in this direction seems likely to possess a very definite survival value. The mode of copulation also explains the asymmetry of the male terminalia.

In species of *Metoligotoma* with a lateral spine on the process of the left hemitergite, the angle between this spine and the main process serves as a guide to the left cercus, which, when adpressed to this angle, forms an efficient clasping organ. This function was overlooked previously (Davis, 1936b, p. 257). The same function appears to be served in *Rhagadochir*, but here the 'ventral process'* and not the left cercus fits into the angle. The nodules frequently found on the inner side of the left cercus (e.g. in *Metoligotoma*, *Notoligotoma*, and many Embiidae) add to the ability of the cercus as a clasping organ when adpressed to some other structure. Nodules may also occur on other structures, e.g. on the hypandrium in *Oligotoma glauerti* and *O. tillyardi*, probably adding to the efficiency of the hold when some other organ is adpressed to the nodulose surface.

The possibility of the extra lobe of the process of the left hemitergite in *O. tillyardi* being used to hold a spermatophore has been referred to earlier (Davis, 1936a, p. 242). Thus an extra lateral appendage to this process may act in three ways (1) as a guide to the left cercus, acting as a clasper; (2) as a guide to the 'ventral process', acting as in (1); (3) as the second lobe of a forcipate structure, not as an organ for clasping the female.

Several modifications of the left cercus-basipodite in *Metoligotoma* possess abilities as clasping organs, in somewhat different ways. The slightly concave and heavily chitinized outer face of the left cercus-basipodite in *M. extorris* forms the base against which the inner tooth of the left cercus is adpressed to act as a clasper; the spinous left cercus-basipodite in *M. illawarrae*, pressed against portion of the membrane of the female abdomen, with the left cercus bent inwards to hold the latter against it, must form a particularly efficient hold; and the bilobed left cercus-basipodite of *M. tasmanica biloba* forms a groove which guides the

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* Ontogenetic studies in the Embiidae may reveal that this is homologous to the structure referred to as the left cercus-basipodite in the Oligotomidae.

downwardly-curved termination of the process of the left hemitergite, the approximation of these two structures forming a much more efficient clasping organ than in the case of *M. tasmanica tasmanica*, in which the process of the left hemitergite is pressed against the left cercus-basipodite without any guide to register against.

Differential characters in structures other than the male terminalia may be of some functional use. The tarsal bladders are probably of service when the insect darts backwards in its web gallery, an act performed by the huge levator tibiae muscles of the hind legs; the bladders are probably of use in disengaging the tarsal claws from the web, by dilation and the forcing upwards of the tarsus, and two would presumably be more efficient than one. Loss of wings in the male does not militate against powers of dispersal, as the female is wingless in all cases; wings in this Order may be regarded as a hindrance (to free motion in the galleries), and their loss facilitates the escape of the insect from predators. The most rapid movement possible in the gallery is backwards, not forwards, and the wings impede backward movement particularly. It has been observed in winged males of *Oligotoma gurneyi gurneyi* and *Notoligotoma nitens* that the wings are carried forward over the head during backward movement in the web, folding about a transverse line somewhat basad to a point half-way from articulation to termen. In these two species, probably throughout the family Oligotomidae, a definite hollow marks this line of folding, and this is present in specimens immediately after ecdysis, that is, it is genetic and not due to somatic modification.

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Corrigenda Part I, p. 238, figs. 18-24, *for* × 20, *read* × 16

Part II, p. 256, line 16, *for* 13.9.26, *read* 13.9.36