Phylogeny and biogeography of the Platystictidae (Odonata)

Tol, J. van

6. The Odonata of Sulawesi and adjacent islands. Part 5. The genus *Protosticta* Selys (Platystictidae)

J. van Tol

Abstract

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The type species of the genus *Protosticta* Selys, *P. simplicinervis* Selys, was described from Sulawesi (formerly Celebes, Indonesia). The present paper provides a revision of all Sulawesi species of the genus, and those of the adjacent island of Buton and the Sangihe Islands. Twelve species are recognized, three of which were previously known (*P. bivittata* Lieftinck, *P. gracilis* Kirby, and *P. simplicinervis*). One nominal species, *P. annulata* Fraser, appeared to be a synonym of *P. simplicinervis*. Consequently, nine species are described as new to science, viz. *P. coomansi* (type locality: Palu: Lindu valley), *P. geijskesi* (type locality: NNE of Malili), *P. linduensis* (type locality: Polewali), *P. marenae* (type locality: Palu: Lindu valley near Gimpu), *P. maurenbrecheri* (type locality: NW of Palopo), *P. pariwonoi* (type locality: N of Ujung Pandang: Maros), *P. reslae* (type locality: Polewali), *P. rozendalorum* (type locality: Sangihe Islands) and *P. vanderstarrei* (type locality: Polewali). Characters of importance for species recognition are the thoracal and abdominal markings, and the structure of the prothorax and anal appendages in the male. Diagnostic characters of females include the structure of prothorax and anal appendages. The females of four species are unknown. The status of the genus *Protosticta* of the family Platystictidae is preliminarily discussed. Its high diversity in Sulawesi is in contrast with the complete absence of Platycnemididae and Euphaeidae, and the virtual absence of the Protoneuridae from this island. Besides, various species as here recognized, show significant variation between populations. The morphological variation is clinal in some species (*P. coomansi*, *P. geijskesi*), presumably related to the geological history of the island.

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Key words. – Platystictidae; *Protosticta*; Sulawesi; Malesia; new species.

Introduction

The composition of the flora and fauna of Sulawesi (formerly Celebes) was the subject of various analyses in the 19th century (e.g. Wallace 1890), resulting in the hypothesis that the biotas of this island are a mixture of Oriental and Australian elements. The fauna has been extensively studied and described during the last 25 years (e.g. Whitmore 1981, 1987; Holloway 1990; Knight & Holloway 1990). The Odonata fauna of the island is no exception to the general pattern of absence of otherwise widespread groups, and remarkable radiation and high endemism in other groups. For instance, the Gomphidae are only represented by two species in Sulawesi, while this family is speciose and also very diverse at the generic level in Borneo. The damselfly families Euphaeidae

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Table 1
List of species included in *Protosticta* Selys. Species of *Protosticta* not occurring in Sulawesi have not been examined.

	Name	Range
1	*antelopoides* Fraser, 1931b: 467	India: Travancore
2	*beaumonti* Wilson, 1997: 57	Hongkong, Guangdong
3	*bivittata* Lieftinck, 1939: 151	SW Sulawesi
4	*coomansi* sp. n.	Sulawesi
5	*curiosa* Fraser, 1934: 134	Lower Burma, western and southern Thailand
6	*damacornu* Terzani & Carletti, 1998: 481	NE India, East Khasi Hills
7	*davenporti* Fraser, 1931: 70	Southern India
8	*feronia* Lieftinck, 1933: 281	Borneo (NW and W)
9	*foersteri* Laidlaw, 1902: 383	Peninsular Malaysia
10	*fraseri* Kennedy, 1936: 67	Assam
11	*geijskesi* sp. n.	Sulawesi
12	*gracilis* Kirby, 1889: 302	Northern Sulawesi
13	*grandis* Asahina, 1985: 334	Northern and western Thailand
	syn. *robusta* Asahina, 1984: 590 [primary homonym of *Protosticta robusta* Fraser]	
14	*gravelyi* Laidlaw, 1915a: 389	Southern India
	syn. ? *mortoni* Fraser, 1924: 500	Southwestern India
	syn. *stevensi* Fraser, 1922: 7	
15	*hearseyi* Fraser, 1922: 5	Southern India
16	*himalaiaca* Laidlaw, 1917: 342	Northern Bengal, Assam, Sikkim
	syn. *lindgreni* Fraser, 1920: 150	
17	*khaosoidaoensis* Asahina, 1984: 588	Northern and SE Thailand
18	ssp. *satoi* Asahina, 1997: 108	Northern Vietnam
19	*kiautai* Zhou, 1986: 465	China (Zhejiang)
20	*kinabaluensis* Laidlaw, 1915b: 37	Borneo (N)
21	*linduensis* sp. n.	Sulawesi
22	*marenae* sp. n.	Sulawesi
23	*maurenbrecheri* sp. n.	Sulawesi
24	*medusa* Fraser, 1934: 135	Lower Burma, western Thailand
25	*pariwonoi* sp. n.	Sulawesi
26	*reslae* sp. n.	Sulawesi
27	*robusta* Fraser, 1933b: 111	Laos
28	*rozendalorum* sp. n.	Sangihe Islands
29	*rufostigma* Kimmins, 1958: 349	S India, Tinnevelly District
30	*sanguinostigma* Fraser, 1922: 6	Southern India
	syn. *cerinostigma* Fraser, 1924: 499	
31	*simplicinervis* (Selys, 1885): cxlv	Sulawesi
	syn. *annulata* Fraser, 1926: 492	
32	*taipokauensis* Asahina & Dudgeon, 1987: 2	Hong Kong
33	*trilobata* Fraser, 1933b: 112	Laos
34	*uncata* Fraser, 1931a: 75	Burma
35	*vanderstarrei* sp. n.	Sulawesi
36	*versicolor* Laidlaw, 1913: 78	Borneo (NW)

Note: The only species originally described in *Protosticta* and now assigned to another genus is *Protosticta carmichaeli* Laidlaw, 1915a: 390, which is the type species of *Drepanosticta* Laidlaw, 1917

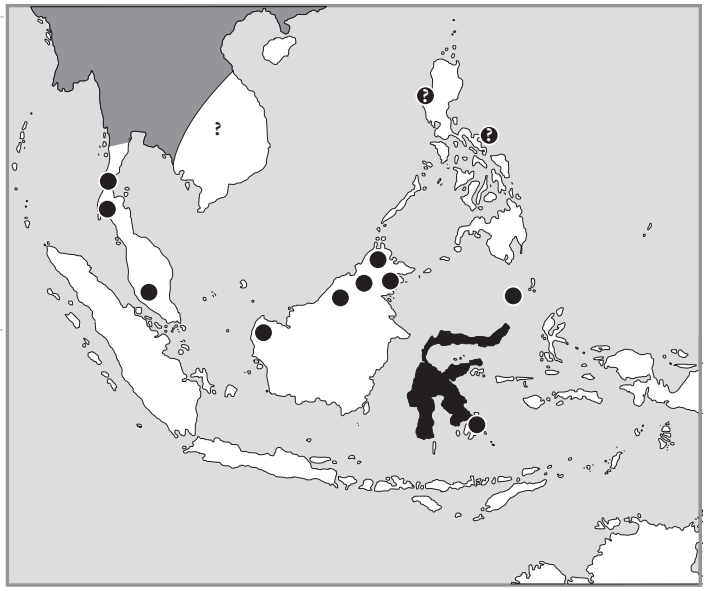


Figure 1. Distribution of the genus *Protosticta* Selys in Southeast Asia. Distribution on mainland roughly indicated only. Species from the Philippines doubtfully belonging to *Protosticta.*

and Platycnemididae are even completely absent from Sulawesi, while hardly any stream in Borneo is without at least a few species of these families. On the other hand, the family Chlorocyphidae is remarkable diverse in Sulawesi with even three endemic genera (van Tol 1998). In the genus *Libellago* Selys, 1840 (Chlorocyphidae) much variation has been noticed in various species, warranting the description of several new species (van Tol in prep.). The subject of this paper, the genus *Protosticta* Selys, 1885 of the Platystictidae, is another example of radiation in Sulawesi, a fact also noticed in such diverse groups as macaques, cicadas (Duffels 1990) and waterstriders (Polhemus & Polhemus 1988, 1990). Similar to these groups, various species in *Protosticta* show small distributional ranges, defining areas of endemism. The present paper is the fifth in a series devoted to the Odonata of Sulawesi (no. 4, see van Tol 1998). In a summarizing paper the phylogeny and biogeography of the Sulawesi Odonata will be central. No recent overview of the Sulawesi dragonflies is available. The last general list was published by Selys (1878). This publication also includes the interesting biogeographical account 'Considérations sur la fauna de la Nouvelle Guinée, des Moluques et de Célèbes'.

Terminology. The terminology of the anatomy generally follows Watson & O'Farrell (1991); in several cases I have added alternative, frequently used terms in brackets. The abbreviations of the names of the institutions are explained in the acknowledgements; the coden RMNH is used for the National Museum of Natural History Naturalis at Leiden (formerly Rijksmuseum van Natuurlijke Historie).

The family Platystictidae

The family Platystictidae (Odonata: Zygoptera) has a transpacific distribution and contains the three subfamilies Palaemnematinae, Platystictinae and Sinostictinae. The Palaemnematinae, with *Palaemnema* Selys, 1860 as single genus included, occurs in Central America and the northern part of South America. At present 42 valid species are recognized (Garrison 1991). The Palaemnematinae are characterized by a CuP vein extending over halfway along the posterior border of the wing (Fig. 2). The speciose second subfamily, the Platystictinae, is known from the westernmost part of the Oriental region eastwards to the Papuan region. Not a single species is known from Australia. The CuP of the Platystictinae ends in the basal half of the posterior border of the wing. Recently, a third subfamily, Sinostictinae, has been proposed for *Sinosticta* Wilson, 1997, a genus of Platystictidae only known from Hong Kong (Wilson 1997), with one species included, viz. *S. ogatai* (Matsuki & Saito, 1996). As in the Palaemnematinae, *S. ogatai* has a long

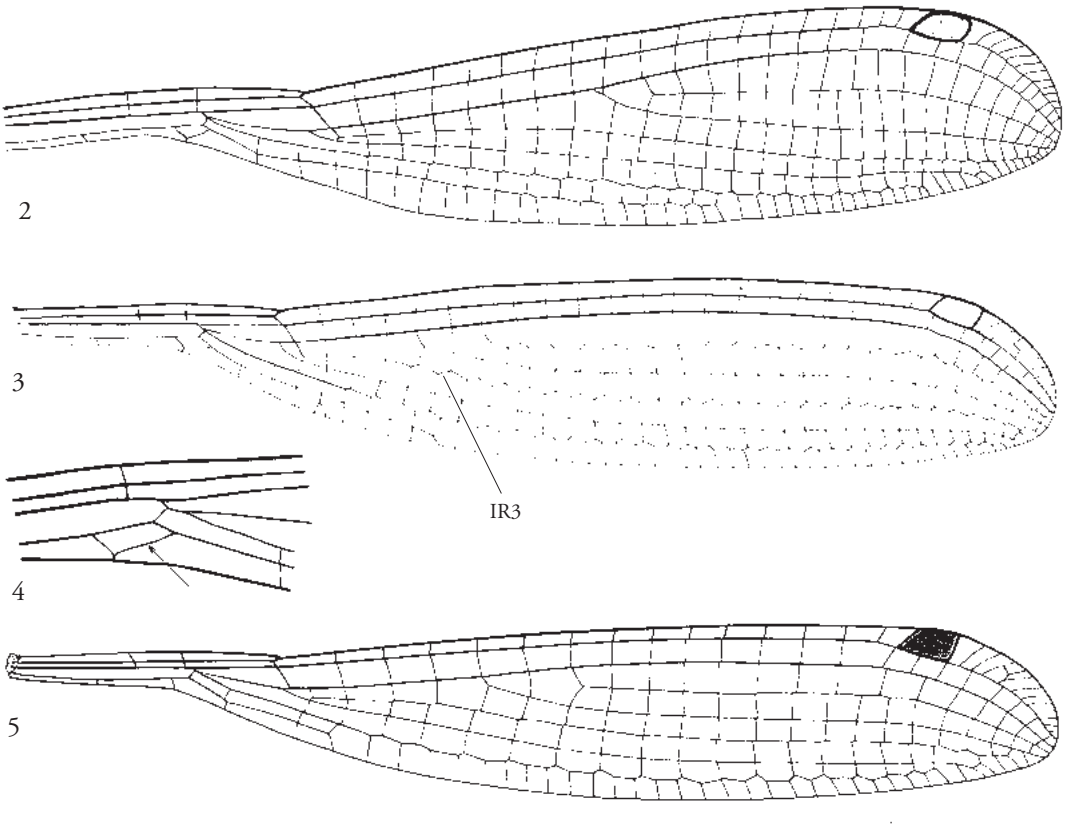
CuP vein, ending in the distal half of the wing border. Besides, it has two to four supplementary postcubital cross-veins in addition to the usual postcubital cross-vein. Unfortunately, this character is not properly illustrated in the photographs and drawings published up to now.

Three genera are recognized within the Platystictinae, *Platysticta* Selys, 1860, *Protosticta* Selys, 1885 and *Drepanosticta* Laidlaw, 1917. The last genus consists of 85 nominal species (84 valid species). *Platysticta* Selys, 1860 (syn. *Ceylonosticta* Fraser, 1931a) has only two valid species (one with two recognized subspecies). It is mainly confined to Sri Lanka (Ceylon), with only *P. maculata deccanensis* Laidlaw, 1915a also occurring in southern India (Fraser 1933a: 126). *Protosticta* presently includes 27 valid species and subspecies (table 1), to which number I add nine new species in this paper.

The most distinct diagnostic character for the Platystictidae, the presence of a supplementary crossvein in the cubito-anal space at the wing base, is, disputably, a synapomorphy for the group. At least Fraser (1957: 41-42) considers this character homologous to the cross-vein found in *Kennedya* Tillyard, 1925 (Protozygoptera: Kennedyidae), a genus described from the Lower Permian. If that hypothesis holds true, this character is a symplesiomorphy for the species of the Platystictidae, so that the monophyly of the Platystictidae has not been established as yet. Then, it is also uncertain to which extent the Platystictinae differ from the Oriental Protoneuridae, with which they share the reduced 1A and CuP veins and several other characters. For the present, I consider the Platystictinae a monophyletic group, based on admittedly weakly founded apomorphies in the shape of the pterostigma and the 'bauplan' of the male appendages. Although the general appearance of some species of *Palaemnema* and some of *Protosticta* is remarkably similar, the sister-group relationship of the Palaemnematinae to the Platystictinae (or Platystictinae+ Sinostictinae) is not soundly established as yet.

The characters traditionally used to distinguish the genera *Platysticta*, *Protosticta* and *Drepanosticta* of the Platystictinae, are given in the key below. Within the Platystictinae, no synapomorphy is known for the species now united in *Drepanosticta*, while the genus *Protosticta* is characterized by the absence of the Ab vein, a cross-vein running from the posterior side of the quadrangle to the posterior margin of the wing or the anal crossing in *Drepanosticta*. Consequently, *Drepanosticta* and *Protosticta* can not be considered valid genera based on this character. This was already foreseen by Laidlaw (1917: 340), in his original diagnosis of *Drepanosticta*, where he noticed that 'the distinction between *Drepanosticta* and *Protosticta* is not of great importance and is liable in individual cases to break down'. A comparison of the larvae of species assigned to either *Protosticta* or *Drepanosticta* (Lieftinck 1934: 468) revealed no important generic distinction. Lieftinck also remarked (p. 464) that *Drepanosticta* is 'a genus very closely allied to *Protosticta*, differing from this only in venational characters of but slight importance'. These statements are based on various observations. At the specific level, Lieftinck (1933: 285) noticed a very close similarity between a *Protosticta* and a *Drepanosticta* '... Indeed I am inclined to think that [*Protosticta*] *feronia*, although immediately distinguished from [*Drepanosticta*] *dupophila* by the generic character found in the anal veins, is closely related to that species, for I can hardly imagine that so striking a similarity can be brought forward by convergence only'. My own studies of both species confirm Lieftinck's observations. These two species share at least one strong and unique character within the Platystictinae, which was apparently overlooked by Lieftinck, making it even more likely that a phylogenetic study will result in a complete new generic subdivision of this subfamily.

However, several presumably monophyletic subgroups in *Drepanosticta* and possibly also in *Protosticta*, differ sufficiently from each other to be distinguished as different genera. Since this is also true for the species groups to which the type species of both genera are assigned, I have refrained from synonymizing *Drepanosticta* and *Protosticta*. The type species of *Protosticta*, *P. simplicinervis*, is a Sulawesi species, and all Sulawesi species lacking the Ab vein have been assigned to *Protosticta* in the present paper. However,



Figures 2-5. Hind wings. – 2, *Palaemnema domina* Calvert (Guatemala); 3, *Platysticta maculata deccanensis* Laidlaw (Travancore, 29 Sep 1932); 4, *Drepanosticta ephippiata* Lieftinck (JvT 11861, NW Sulawesi, Dumoga Bone NP); 5, *Protosticta simplicinervis* Selys (N. Sulawesi. – illustration from M.A. Lieftinck archives).

it is unlikely that this character will prove to be an autapomorphy for *Protosticta*. Based on the analysis of characters as general appearance, coloration and structure of secondary genitalia, several species of Sulawesi Platystictinae here assigned to *Protosticta* possibly make the genus concept non-monophyletic. The most prominent example is *P. vanderstarrei* sp. n., a small, slender and dark species, in general appearance more similar *Drepanosticta ephippiata* Lieftinck, than to other species of *Protosticta* described from Sulawesi in this paper. It has been incorporated in the present paper as a *Protosticta*, since it lacks the Ab vein. Platystictidae from the Philippines, as yet undescribed, possibly are more closely allied to *P. vanderstarrei.* I also have studied two new species of *Drepanosticta* in the present sense from SE Sulawesi and Kabaena (off SE Sulawesi), which are more similar in general appearance to *Protosticta* than to the other species of *Drepanosticta* of Sulawesi (RMNH Leiden). With the same arguments, I have left them for my future paper on the Sulawesi *Drepanosticta* species. After these revisions, I hope to able to present a phylogeny of the Platystictidae, resulting in at least a subdivision of the subfamily Platystictinae into monophyletic genera.

SYSTEMATIC PART

Platystictidae

Platystictinae. – Laidlaw 1924a: 360
Platystictidae. – Fraser 1957: 41; Davies & Tobin 1984: 103.

The genera included in the Platystictinae can be

distinguished by the following characters (modified after Laidlaw 1917, 1924b).

1. IR3 (= radial sector) markedly fractured (Fig. 3) (anal bridge present, joining Anal crossing Ac, sectors of Arculus not stalked) . . . . *Platysticta* Selys
– IR3 straight (Fig. 5) 2
2. Anal bridge present, joining Anal crossing or hinder margin of wings, sectors of Arculus stalked (Fig. 4) . . . . . *Drepanosticta* Laidlaw
– Anal bridge absent (Fig. 5) . . . . . *Protosticta* Selys

Protosticta Selys

Protosticta Selys, 1885: cxlv (as subgenus of *Platysticta*, original diagnosis, type species *Protosticta simplicinervis*).– Laidlaw 1917: 339-343 (generic characters); Laidlaw 1924b: 306-307 (generic characters, notes on species); Bridges 1994: III.43 (catalogued).

Characters. – As mentioned above. The original diagnosis by Selys reads as follows (my translation of the French text): 'Very similar to subgenus *Platysticta* (sensu stricto) from which it only differs by the absence of the rudiment of the inferior sector of the triangle, so that it resembles (but only in this respect) the genuine *Alloneura* in which this rudiment is also lacking. But it possesses, like the other two subgenera of *Platysticta* a basal supplementary post-cubital vein between the wing base and the normal [? pcv], that is characteristic of this large genus and which I unjustly did not mention when I erected it'.
Distribution. – The genus *Protosticta* has been recorded from India (Fraser 1933a), Burma and Thailand (Asahina 1984, Hämäläinen & Pinratana 1999), Laos (Fraser 1933b), Vietnam (Asahina 1997), China (Guangdong and Zhejiang provinces) (Zhou 1986, Wilson 1997), Hong Kong (e.g. Wilson 1995), the Malaysian peninsula and Borneo (Lieftinck 1954), Celebes (Sulawesi) (Selys 1885, Lieftinck 1939), and the Philippines (see below). In India, most species have been recorded from the southern part of the country (cf. table 1), but others are confined to Assam. Although Odonata have been collected in Borneo in most parts of the island, not a single specimen of *Protosticta* is available from the southeastern part (Fig. 1). Both firstly described species of *Protosticta*, *P. simplicinervis* Selys, 1885, and *P. gracilis* Kirby, 1889, are from Celebes. Species of Platystictidae with generic characters of *Protosticta* in the present sense, have been mentioned from the Philippine islands of Luzon and Polillo (Hämäläinen & Müller 1997). Recently, RMNH Leiden purchased the collection of R.A. Müller, which enabled me to examine these specimens. Although the wing characters of these undescribed species indicate a position in *Protosticta*, I consider it more likely that a phylogenetic analysis will reveal a close relationship to other Platystictidae of the Philippines now attributed to *Drepanosticta*, rather than to *Protosticta* from Sulawesi. Therefore, I have indicated the locations of the Philippine *Protosticta* (Fig. 1) with question marks.
In the present paper, not only species found in Sulawesi proper, but also those collected on Sangihe island, located north of NE Sulawesi, are treated. One of the most common and widespread species of Sulawesi is recorded here from Buton, an island off SE Sulawesi. The distributional data, as given in table 1 and Fig. 1, indicate that no species of this genus has ever been collected on Sumatra, Java, the Lesser Sunda islands, the Moluccas and New Guinea. Almost certainly these data reflect reality, since quite intensive collecting of Odonata was executed on these islands. Moreover, many specimens of *Drepanosticta* Laidlaw are known from these places, indicating the careful search for Platystictidae in relevant habitat.

Infrageneric relationships. – Awaiting a generic revision, the Sulawesi species can be divided into the following 'species groups'. The relationships of these groups to each other, and to other species of *Protosticta*, are presently not clear, and I have refrained from using the groups in arranging the species in this paper.

The *bivitatta*-group. – With *P. bivittata* and *P. maurenbrecheri,* characterized by the presence of an antehumeral stripe.

The *geijskesi*-group. – With *P. geijskesi*, *P. linduensis*, *P.*

marenae and *P. pariwonoi*, characterized by the 'boxing glove' inferior anal appendage.

The *gracilis*-group. – With *P. coomansi*, *P. gracilis* and *P. reslae*, characterized by the sharp and long inner tooth of the inferior anal appendage, and blue coloured dorsum of abdominal segment 10.

The *rozendalorum*-group. – With *P. rozendalorum*, characterized by the shape of the appendages.

The *simplicinervis*-group. – With *P. simplicinervis*, characterized by the tubercles of the median lobe of the prothorax.

The *vanderstarrei* group. – With *P. vanderstarrei*, characterized by small size, the dark colouration, and the very short stripe over synthorax.

Key to the males of *Protosticta* species of Sulawesi

1. Dark and small species; hind wing 19-22 mm; abdominal segment 8 brownish black without pale markings; synthorax dark castaneous, with short yellowish, or somewhat bluish pale stripe over metepisternum; metepimeron and metakatepisternum brownish black, without any trace of pale coloration (Fig. 89) . . . . . *P. vanderstarrei* sp. n.
– Larger species; hind wing more than 23 mm; more conspicuous pale markings on synthorax, especially pale markings on metepimeron and metakatepisternum and abdominal segment 8 . . . 2

2 (1) Dorsum of abdominal segment 10 black; all species with reduced inner-tooth of inferior appendage; species with blue coloration on abdominal segments 8-9 have mandibles with at least anterior half brownish black, usually black except for a small basal pale spot 3
– Dorsum of abdominal segment 10 blue, discoloured in poorly preserved specimens, but always recognizable; inferior appendage variable . 7

3 (2) Superior anal appendage with a ventral tooth approximately halfway, particularly well visible from innerside (Fig. 46), dorsal tooth absent; inferior appendage with stout terminal structure, the innertooth connected with the distal part by a chitinous veil (Fig. 45). Sangihe Islands . . . . . *P. rozendalorum* sp. n.
– Superior anal appendage without ventral tooth, but with a more or less distinct dorsal tooth, but never with a tooth directed ventrad; top of inferior appendage a 'boxing glove' (e.g. Fig. 20) 4

4 (3) Anterior lobe of prothorax with lateral sides significantly widened, particularly well visible in lateral view (Figs 62, 64) 5
– Anterior lobe of prothorax with fore and hind margin parallel-sided; both margins may be somewhat raised, but lateral parts not a disc with raised margins 6

5 (4) Larger species, abdomen of males 26-27 mm; anterior lobe of prothorax significantly widened (Fig. 62); inferior anal appendage stoutly built (Fig. 28-29) . . . . . *P. linduensis* sp. n.
– Smaller species, abdomen of male 23-24 mm; anterior lobe of prothorax less widened (Fig. 64); inferior appendages less robust (Fig. 32- 33) . . . . . *P. marenae* sp. n.

6 (4) Hind margin of posterior lobe of prothorax simple without distinct characters (but in some populations with more or less erect teeth), and anterior margin of anterior lobe only with a slender ridge (Fig. 58). Variable species . . . *P. geijskesi* sp. n.
– Hind margin of posterior lobe of prothorax with more or less erect teeth, and anterior margin of anterior lobe distinctly swollen (Fig. 68) . . . . . *P. pariwonoi* sp. n.

7 (2) Synthorax with distinct antehumeral stripe; dorsal spine on superior anal appendage large and approximately halfway; tip of inferior appendage stout and pointed, not curled (Figs 9, 36) 8
– Synthorax anterior to humeral suture concolorous, without antehumeral stripe; dorsal spine on superior anal appendage smaller and less distinct; extreme tip of inferior appendage with hook-like structure, which may be inconspicuous or as big as the base of the tip (e.g. Fig. 13) 9

8 (7) Large species (hind wing > 26 mm); innertooth of inferior appendage huge and shiny (Fig. 9) . . . . . *P. bivittata* Lieftinck
– Smaller species (hind wing < 25 mm), innertooth of inferior appendage inconspicuous (Fig. 36) . . . . . *P. maurenbrecheri* sp. n.
9 (7) Middle lobe of prothorax distinctly raised to paired cone-like protuberance (Fig. 74); hooklike tip of inferior appendage huge (Fig. 49) . . . . . *P. simplicinervis* Selys
– Middle lobe of prothorax smooth, without cone-like protuberance; hook-like tip of inferior appendage usually inconspicuous to hardly visible . 10
10 (9) Protuberance (tooth) on dorsal side of superior appendage at approximately two-thirds from base of appendage; tip of superior appendage distinctly broadened in lateral view (Fig. 40) . .*P. reslae* sp. n.
– Protuberance approximately halfway or in basal half of superior appendage 11
11(10) Innertooth of inferior appendage huge and rather basal, in dorsal view its base approximately at level of dorsal spine of superior appendage, its tip nearly reaching the visible base of appendages (Fig. 23-24) . . . . . *P. gracilis* Kirby
– Innertooth, although very variable, much smaller, in dorsal view the tip approximately at level of dorsal tooth of superior appendage (Figs 12-16) . . . . . *P. coomansi* sp. n.

Key to the females

Species of the following species are unknown: *Protosticta gracilis*, *P. linduensis*, *P. maurenbrecheri*, and *P. reslae*.

1. Synthorax with antehumeral stripe; anterior half of dorsum of abdominal segment 9 pale (Fig. 98); abdominal segment 9 and valvae short (Fig. 90). Hind wing 42-44 mm . . . . . *P. bivittata* Lieftinck
Note: *P. maurenbrecheri* will probably also key out here; it may at least be distinguished from *P. bivittata* by its smaller size.
– No antehumeral stripe 2

2 (1) Middle lobe of prothorax with a paired protuberance; robust species . *P. simplicinervis* Selys
– Middle lobe of prothorax flat or only somewhat convex, without a paired protuberance 3
3 (2) Small and dark species with stripe above metastigma very short (cf. Fig. 89); valve very short (Fig. 97) . . . . . *P. vanderstarrei* sp. n.
– Larger species, with stripe above metastigma longer; valve longer 4
4 (3) Hind margin of prothorax with sharp and distinctly erect lateral corners 5
– Hind margin of prothorax acute, sharp or bluntly shaped, but without distinctly erect lateral corners 6
5 (4) Pale markings at sides of segment 9 of abdomen usually in lower half only, thus not or only just visible in dorsal view (Fig. 92, 100). Widespread in Sulawesi, including Southwest Sulawesi . . . . . *P. geijskesi* sp. n.
– Pale markings at sides of segment 9 more extensive, and clearly visible in dorsal view (Figs 94, 102). Southwest Sulawesi only . . . . . *P. pariwonoi* sp. n.
6 (4) Segment 9 of abdomen with two large pale (blue) spots, virtually from anterior to posterior margin, and well visible in dorsal view (Figs 91, 99); segment 8 only with a small paired pale spot in latero-anterior corners; lateral corners of hind margin of prothorax bluntly shaped; body usually stoutly built . . . . . *P. coomansi* sp. n.
– Segment 9 of abdomen with pale spots smaller, covering up to c. 60% of the length of the segment; spot usually higher than long; pale spot in latero-anterior corners of segment 8 larger; lateral corners of hind margin of prothorax variable; species of diverse stature 7
7 (6) Medium-sized species (hind wing 20 mm) from Central Sulawesi; pale markings of segment 8 and 9 clearly visible in dorsal view (Figs 93, 101) . . . . . *P. marenae* sp. n.
– Larger species (hind wing 24 mm) from Sangihe islands; pale markings of segment 8 invisible in dorsal view, those of segment 9 just visible in dorsal view (Figs 95, 103) . . . . . *P. rozendalorum* sp. n.

Protosticta bivittata Lieftinck
(Figs 7-9, 54-55, 78, 90, 98, 106, 110)

Protosticta bivittata Lieftinck, 1939: 151-154, Fig. 5. Holotype male: 'Célèbes' (in MNHP) [examined] – Lieftinck 1971: 122 (notes on types); Davis & Tobin 1984: 107 (catalogued); Tsuda 1991: 7 (catalogued); Bridges 1994: VII.34 (catalogued).

Description

Remarkably large and robust species with very long abdomen.

Male. – Head. Labium with labial palps brownish black, median lobe with subquadrangular twinspot on both sides of mid-suture; labrum with ovoid median depression, bluish white with black anterior margin, broad in the middle and tapering towards the corners; anterior parts of mandible bluish white without any black marking; anteclypeus bluish white; postclypeus black; remaining part of head partly shining; partly velvet black; antennae concolorous brown.

Thorax. Prothorax (Figs 54-55) with anterior and median lobe creamish white, posterior lobe black; anterior lobe with erect anterior border, flattened towards lateral corners; median lobe rather smooth and simple; posterior lobe very distinct by two lateral 'inner- horns' erected in c. 100° position, i.e. pointing somewhat apicad, horns slender and approximately as high as length of posterior lobe in dorsal view. Synthorax (Fig. 78) black with bright creamish white fasciae; mesepisternum with a light coloured stripe along apical half of dorsal carina; stripe pointed anteriorly and posteriorly, but anterior side broader than posterior side; parallel-sided pale fascia above metastigma over ventral side of mesepimeron and dorsal 3/5th of metepisternum; dark stripe over metastigma continuing over metakatepisternum; remaining part of metepimeron creamish white. Legs greyish. Wings reaching to just beyond half-length of abdominal segment 5; Arculus distal to Ax2, origin of R4+5 just proximal to subnodus (Fig. 106); six cells between origin of IR3 and R3; nine cells between Cux (Ac) and place where CuP meets hind margin of wing.

Abdomen. Segments 1-2 somewhat inflated, segments 8-10 much inflated; segments 1-2 dorsally ochraceous, lateral sides creamish white; dorsum of segments 3-6 anteriorly creamish white, passing posteriorly to brown or brownish black; segment 7 brownish black except for anterior 1/6th; segments 8- 10 (Fig. 7) with distinct pale blue marking, latero-posteriorly brownish black; hind margin of segment 10 with narrow black stripe. Anal appendages ochraceous; superiors in dorsal view (Fig. 8) nearly straight, in lateral view (Fig. 10) club-shaped with a long and slender protuberance ('tooth'), longer than diameter of appendages; inferiors (Fig. 9) greatly differing from other *Protosticta* species of Sulawesi, with top in ventral view provided with strongly chitinized, shiny, hook-shaped structure, inner part strongly connected with outer part.

Female. – General appearance as male, but abdomen much shorter. Head as male. Prothorax with hind margin of posterior lobe with similar pair of erect 'inner-teeth'; synthorax and wings as male, wings reaching to anterior part of segment 6. Abdomen more robust than of male, first segments rather narrow, segments widening posteriorly; colour brown with paler markings on lateral side of segment 1, pale annulae on anterior 1/8th of segment 3, 1/6th of segment 4, 1/5th of segments 5-7; segments 8-10 as follows (Figs 90, 98): segment 8 dorsally black with antero- lateral pale markings tapering posteriorly towards fully dark posterior side, segment 9 with anterior half pale and posteriorly brown, short, segment 10 brown.

Measurements. – Male (n=4): abdomen incl. appendages 48-53 mm, hind wing 26-29 mm; female (n=2): abdomen 42-44 mm; hind wing 28-29 mm.

Comparative notes. – Males and females are easily distinguishable from most other *Protosticta* of Sulawesi by the presence of an antehumeral stripe, the presence of 'middle-horns' at the hind margin of the posterior lobe of the prothorax, and their considerable size. *P. maurenbrecheri* is similar in general appearance (including size and presence of an antehumeral stripe), but it lacks the 'inner-horn' at the hind margin of the posterior lobe of the prothorax; especially, however, the inferior appendages are completely different.

The female of *P. bivittata* is immediately recognizable by the pale anterior half of segment 9, but the female

Figure 6. – Localities in Sulawesi where specimens of *Protosticta* were found.

of *P. maurenbrecheri* is unknown and presumably has similar coloration.

Material examined

Holotype, as mentioned above. – Other material: SW Celebes: Bonthain, 1884, 1 female (C. Ribbe) [paratype of *P. bivittata* Lft.] ex IRSN [JvT 1841]; Bantimurung (N. of Ujung Pandang), Pattunuang Asue, 200 m, 31 May 1982, 1 male (M.A. Lieftinck) [JvT 1842]; same site, cave near praw rock, 24 Sep 1983, 2 males 1 female (S.S. Pariwono) [JvT 1843, 1845, 1846]; Maros, Bantimurung area, Biseang Labboro, 8 Oct 1983, 1 male (S.S. Pariwono) [JvT 1844] all specimens in RMNH.

Remarks

Habitat. – Apparently an uncommon and possibly seasonal species. I have investigated the area of Pattunuang Asue and Biseang Labboro myself in 1989, where Lieftinck and Pariwono collected the species in small numbers in 1982 and 1983. Although I found numerous specimens of *P. pariwonoi* sp. n., no specimen of the present species was captured. The site is dominated by a rivulet flowing through disturbed forest on limestone hills. Water dripping from the limestone rocks gathers to several shaded trickles in the river valley.

Distribution. – Only known from SW Sulawesi; the paratype is from Bonthain (usually an indication of the Lompobatang mountain, no altitude given), all other specimens are from the Bantimurung area, north of Ujung Pandang (see Fig. 110).

Protosticta coomansi sp. n.

(Figs 10-16, 56-57, 79, 91, 99, 111)

Type material. – Holotype male: 'Celebes (Paloe) Lindoevlakte, XVIII.' 850 mbz, 8-VIII-[19]40. Coll CdR' [CdR = Coomans de Ruiter] [JvT 2016] in RMNH. – Paratypes 76 males 6 females, as follows: Paloe, Lindoevlakte, 850 m, 8 Aug 1940, 2 males 1 female (Coomans de Ruiter) [JvT 2017-2019]; Same site, 9 Nov 1940, 1 male (Felix) [JvT 2014]; Same site, 15 Jan 1941, 1 female [JvT 2015]; 50 km SE Palu, Lore Lindu NP, foothill brooks Dongi Dongi shelter,

4-9 Dec 1985, 7 males 1 female (J. van Tol) [16829-16835, 16870]; 65 km SSE Palu, Lore Lindu NP, foothill brooks nr Marena shelter, 600 m, 14-17 Dec 1985, 30 males 1 female (J. van Tol) [16836- 16865, 16871]; Gimpu, Lore Lindu NP, 450 m, 1°40'46"S 120°03'30"E, 2-3 Apr 1997, 4 males (J. van Tol) [JvT 16578, 16582, 16589, 16590]; N of Gimpu, just outside Lore Lindu NP, 450 m. 1°37'S 120°02'E, 4 Apr 1997, 20 males 2 females (J. van Tol) [JvT 16596-16617]; S of Palu, Lore Lindu NP, Kamarora, 700 m, 1°11'53"S 120°08'16"E, 7-8 Apr 1997, 12 males (J. van Tol) [JvT 16640-16643, 16646, 16648-16654] all in RMNH, except 8 males (Lore Lindu, Gimpu) in MBBJ, and 2 males in ZMAN.

Additional material (excluded from type series). – All from Sulawesi (Celebes), arranged approximately from north to south): Leok, 25 Jan 1941, 1 male (J. J. van der Starre); Sabang, Dampelas, 30 Jan 19941, 2 females (J.J. van der Starre); NE Palu, road Tawaeli-Pangi near Wentira, 800 m, 00°43'22"S 119°59'49"E, 6 Apr 1997, 1 female (J. van Tol); Donggala, 4 Jan 1941, 4 males (J.J. van der Starre); c. 40 km over road N of Wotu, brooklet on steep slope, 500 m, 91JvT20, 2°15'S 120°46'E, 29 Apr 1991, 12 males 1 female (J. van Tol); 30 km N of Wotu, Sg Anoa, waterfall, ponded sites and small tributaries, 2°20'30"S 120°47'45"E, 23, 26 October 1993, 11 males 1 female (J. van Tol);c. 15 km NNE Malili, tributary of Sg. Malili, 150 m, 2°32'S 121°12'E, 2 May 1991, 1 male (J. van Tol); Between Malili and Wasapundo, 24 Sep 1993, 1 male (M.T. Wasscher); 3 km S of Soroako, 25 Sep 1993, 1 male (M.T. Wasscher); 45 km ENE Malili, stream E side Danau Matana near Salura, 2°31'45"S 121°29'00E, 450 m, 19 Oct 1993, 3 males 1 female (J. van Tol); Tappalang, 21 Jan 1940, 1 female (J.J. van der Starre); Loewoe, Todjamboe, 1000 m, 16-17 Jul 1936, 1 male (L.J. Toxopeus); Idem, 18 Jul 1936, 2 males 1 female (L.J. Toxopeus); Tojambu, 17 Jun 1982, 1 male (M.A. Lieftinck); 10 km NW Palopo (km 15 road Palopo-Rantepao), Salo Tandung, 400 m, 91JvT15, c. 2°58'S 120°07'E, 27 Apr 1991, 7 males (J. van Tol); c. 10 km WNW Palopo, near Tojambu, river above km 23 from Palopo, 800 m, 2°56'S 120°07'E, 29 Apr 1991, 1 male (Yohan); 10 km NW Palopo: Salo Tandung and tributaries, 300-600 m, 2°57'00"S 120°07'30"E, 30 Oct 1993, 1 male (J. van Tol); Tojambu or direct surroundings, Jul / Aug 1991, 11 males (Yohan); Nanggala, Rantepao, 900 m, Sep 1937, 1 male (F.C. Drescher); 58 km N of Majene, Onan, Sg Parabaya, 19 Nov 1993, 2 males (J.P. & M.J. Duffels) [JvT 6009, 6042]; Polewali, 6 Aug 1940, 5 males 4 females (J. J. van der Starre); Polewali, 23 Oct 1940, 2 males 1 female [identified as *Protosticta* spec. E by Lieftinck]; c. 30 km E of Maros, Cakar Alam Labang, 4- 500 m, 91JvT11, 20 Apr 1991, 2 males (J. van Tol) in RMNH, partly to be deposited in MBBJ.

Description

Relatively large and stout species with significant variation between populations. An analysis based on sufficient material from all parts of the species range is needed to reveal any distinct patterns in variation. Only material from the area south of Palu, the present Lore Lindu National Park, is here considered 'typical'. See below paragraph 'Geographical variation'.

Male [holotype, JvT 2016]. – Head. Labium ochraceous to chestnut brown, the palps somewhat darker; mandibles bluish white, passing anteriorly to brown; labrum bluish white, the anterior one-fourth black (holotype with two dark spots as an artefact), boundary between black and white sharp, but somewhat irregular; anteclypeus bluish white as labrum; postclypeus and remaining part of head black, partly glossy, partly matt-black. Antenna castaneous (flagellum broken in holotype).

Thorax. Pronotum (Figs 56-57) with anterior margin brown, straight, anterior lobe rather narrow, anteriorly bordered with a distinct transversal ridge; median lobe ochraceous yellow, with flat tubercles with various brown markings; hind lobe black, relatively small, with posterior margin straight and the lateral parts inconspicuously erect. Synthorax (Fig. 79) brownish black with metallic shine; creamish yellow coloured stripe over mesepimeron and metepisternum parallel to metapleural suture and running just over metastigma; metepimeron creamish yellow, centrally with a brown marking against metapleural suture posteriorly tapering towards suture. Legs greyish to brownish yellow, the joints somewhat darker. Wings 30 mm long (almost all somewhat damaged), Arculus just distal to Ax2; origin of R4+5 well proximal to subnodus; six cells between origin of IR3 and R3; nine cells between Ac (Cux) and place where CuP meets hind margin of wing.

Abdomen. Long (including appendages 44 mm), not extremely slender, with coloration relatively inconspicuous. Segments 1-2 relatively little swollen; segments 8-10 strongly inflated; dorsum of segment 7 strongly setose with setae nearly as long as diameter of segment; segment 1 ochraceous, segments 2-6 predominantly pale brown, anteriorly with ochraceous rings and posteriorly passing to dark brown; segments

7-8 dark brown except for the dark ochraceous anterior one-fifth of each segment; dorsum of segment 8- 10 bright pale blue; tergites 8-10 laterally brown. Anal appendages (Figs 10-16) with superiors in basal part strongly built, dorsally ending in a light-coloured tooth, ventral side in innerview scythe-shaped, but ending in a knob; inferiors with stout basal part, posterior part curved subcircularly outwards, tops of inferiors approaching, but extreme tips not curved outwards; subterminally a stout tooth at innerside (Fig. 13), approximately perpendicular to body axis.

Female (Gimpu, JvT 16610). – Head and thorax not significantly different from male; abdomen with segment 1 dorsally with brown triangular marking, narrow anteriorly and widening posteriorly, remaining part creamish white; segment 2 dark brown, ventro-anteriorly against annulus with a creamish triangular marking; segments 3-7 brown with small markings anteriorly on segment 3, gradually increasing in size per segment to a larger subsquarish spot covering c. one-third the width of each side of the segment, dorsally leaving dark coloration; segment 8 (Figs 91, 99) short, brown, anteriorly with a paired pale spot, segment 9 brownish black, with a paired pale oval lateral marking, in lateral view c. half the height of the segment, anteriorly creamish white, posteriorly blue; segment 10 brownish black. Anal appendage short, dark; outer valve and terebra reaching just beyond anal appendages, stylus long and slender.

Geographical variation. – Male with significant geographical variation (variation in female largely unknown), particularly with respect to shape of the anterior margin of the prothorax, and the inner tooth of the inferior anal appendages; also the coloration of markings of segments 8-10 in the male is varying between populations and specimens, especially in the basal part of segment 8, which may be entirely blue or partly brownish black as the preceding segments. Variation is clearly demonstrated for the inferior anal appendages in Figs 14-16, for specimens from the Maros area (tip of SW Sulawesi), Gimpu (Central Sulawesi), and Leok (northern peninsula), respectively. They illustrate the general trend from south to north in the increase in size of the inner tooth of the inferior appendage. Also, in some populations (Maros, Polewali) the inner tooth is pointing not perpendicular to the body axis, but more in apical direction. The anterior ridge of the prothorax varies from bordered with two subparallel transversal ridges (Tojambu area) to the more conspicuous anterior ridge and indistinct posterior ridge, as in specimens from the Lindu valley. All these specimens are taken together here under the name *Protosticta coomansi,* since I have been unable to find distinct and discrete morphological characters between the specimens from various localities. Although some populations of *Protosticta coomansi* have characters in which they approach *P. gracilis*, it seems that (the only extant collection specimen of) *P. gracilis* is sufficiently different to separate both at the species level. However, the actually observed differential characters between both taxa may be the result of the absence of any material collected between Leok and the easternmost part of the Minahassa (Tondano), since *P. gracilis* is obviously the extreme form of this geographical trend. The status of the third taxon in this group, *Protosticta reslae*, seems to be better established.

Measurements. – Variation in measurements among populations: Leok (n=1) wing 30 mm, abdomen including appendages 45 mm; Kamarora (n=5) wing 29 (26-30), abdomen 40 (37-42); Gimpu (n=5) wing 27.5 (27-28), abdomen 40.5 (39-42); Salura (n=3) wing 29 (28-29), abdomen 42 (41-42); Polewali (n=5) wing 32 (31-33), abdomen 44.5 (42-46) mm.

Comparative notes. – *Protosticta gracilis* can immediately be distinguished from *P. coomansi* by its enormous inner tooth of the inferior appendage pointing obliquely apicad. How conspicuous this character may seem, it is easily overlooked. Several specimens of *P. coomansi* were identified as and labelled 'compared with the type' [of *P. gracilis*] by M.A. Lieftinck. Specimens here assigned to *P. coomansi* show distinct variation within and between populations, especially in size and shape of the inner tooth, although the giant size of *P. gracilis* is not reached. Besides, the tooth is pointed perpendicular to the body axis in all specimens. *Protosticta reslae* sp. n. may be distinguished

from *P. coomansi* by the shape of the superior appendage in lateral view: the scythe-shaped ventral side in *P. reslae* is much broader than in *P. coomansi*; secondly the dorsal tooth is located far posterior to the base of the ventral projection in *P. reslae*, whereas the dorsal tooth is located approximately above the ventral projection in the basal half of the appendage in *P. coomansi*. The holotype of *P. gracilis* has the tooth and ventral projection also wide apart, but the scytheshaped ventral side is slender as in *P. coomansi*. Finally, both specimens of *P. reslae* have the ventral side of the pale stripe over the synthorax with a distinct emargination, while this stripe is straight in both other species.
The female differs structurally from other common Sulawesi *Protosticta* species, especially *P. geijskesi*, by its shorter valve and terebra, and the absence of an erect hind margin of the prothorax; in coloration it is characterized by the large pale spot in abdominal segment 9.

Remarks
Etymology. – *Coomansi*, after Mr. Louis Coomans de Ruiter (1898-1972). Coomans de Ruiter lived in Sulawesi (Manado, Ujung Pandang) from 1938 to 1942, was extremely interested in collecting Odonata, and has discovered many interesting and new species in Sulawesi.
Habitat. – Mostly confined to brooklets and foothill streams from c. 100 m up to 1000 m above sea level. It is not confined to densely shaded small streams, but has also been found along the Salo Tandung, a rivulet of c. 10 meter wide, only locally shaded by rather open secondary forest. The larvae were possibly living in the small seepage areas present, but the adults were collected from shrubs hanging from the river banks. Most specimens, however, do come from densely forested areas, where the specimens hang in the shade all day, but are most active when spots of sunlight reach the stream.
Distribution. – Widespread in Central Sulawesi, not observed in the southeastern peninsula, and uncommon in the northern peninsula north of Palu, and in the southwestern peninsula (Fig. 111).

Protosticta geijskesi sp. n.
(Figs 17-20, 58-59, 80, 92, 100, 112)

Type material. – Holotype male: SW Sulawesi: c. 15 km NNE Malili, tributary of Sg. Malili, fast flowing clear water, half shaded, 150 m, 2°32'S 121°12'E, 2 May 1991 (J. van Tol) in RMNH [JvT 1923]. – Paratypes: 'S. Baebunta / donker boschbeekje / 25/8/'40' and 'L.A.A.M. leg.' [indicating the Baebunta river, shaded forest stream, 25 August 1940, collected by L.A.A. Maurenbrecher], 2 males, in RMNH [JvT 1917-1918]; SW Sulawesi: c. 15 km NNE Malili, tributary of Sg. Malili, fast flowing clear water, half shaded, 150 m, 2°32'S 121°12'E, 2 May 1991, 3 males (J. van Tol) 2 in RMNH, 1 in MBBJ [JvT 1921-1922, 1924]; 30 km N of Wotu, Sg Anoa, waterfall, ponded sites and small tributaries, 2°20'30"S 120°47'45"E, 23 Oct 1993, 1 male (J. van Tol) [JvT 1499]. Other material (excluded from type series, arranged approximately from north to south). – **Sulawesi**: Sabang, Dampelas, 30 Jan 1941, 1 males (J.J. van der Starre) [JvT 1891]; Same site, 28 Nov 1940, 1 male (J.J. van der Starre) [JvT 1894]; 58 km N of Majene, Onan, Sg Parabaya, 19 Nov 1993, 5 males (J.P. & M.J. Duffels) [JvT 6010, 6015, 6032-6034]; Madjene, 8 Nov 1939, 30 Nov 1939, 13 Nov 1940, 23 Apr 1940, 3 males 1 female (J.J. van der Starre) [JvT 1910-1913]; Kolonedale, 8 Aug 1941, 3 males (J.J. van der Starre) [JvT 1914-1916]; 28 km NE of Luwuk: S Bantayan nr crossing road Kajutanju-Siuna, c. 60 m [100 m on label], 0°47'S 123°00'E, 89JvT006, 30 Jan 1989, 2 males (J. van Tol) [JvT 1895, 1896]; Same site, 89JvT14, 7 Oct 1989, 11 males (J. van Tol) [JvT 1898-1908]; 15 km NNE of Luwuk, Sg Biak at road Biak-Poh, 0°49'S 122°50'E, 89JvT013, 6 Oct 1989, 1 male (J. van Tol) [JvT 1897]; NNW of Batui, Batui river at Sinsing camp, 90 m, 89JvT023, 1°09'S 122°21'E, 15-17 Oct 1989, 1 female (J. van Tol) [JvT 1909]; same site, 14-17 Oct 1989, 1 male (much damaged) 1 female (J.P. Duffels) in ZMAN [JvT 16878-16879]. – SE Sulawesi: S of Sanggona: Mokowu river near Mokowu camp, 150 m asl, 3°48'S 121°39'E, 20 Oct 1989, 1 male (J. Huisman) [JvT 1975]; Same site, 89JvT031, 29-31 Oct 1989 and 5-6 November 1989, 70 males, 2 females (J. van Tol) [females JvT 5144, 11886]; S of Sanggona, Gunung Watuwila, Sg Lalonduwasi nr Centipede camp, c. 1050 m, 89JvT035, c. 3°49'S 121°40'E, 3 males (J. van Tol) [JvT 5194-5196]; Moramo, Sg. Moramo, 200 m, S8939, 16-17 Nov 1989, 3 males (R. de Jong) [JvT 1976-1978]. – SW Sulawesi. – c. 40 km over road N of Wotu, brooklet on steep slope, 500 m, 2°15'S 120°46'E, 91JvT020, 29 Apr 1991, 1 male 1 female (J. van Tol) [JvT 1919, 2031]; 45 km ENE Malili, Salura, brooklets E side Danau Matana, 2°31'45"S 121°29'00"E, 450 m, 19 Oct 1993, 19 males (J. van Tol) [JvT 1420-1423, 1425-1428, 1430-1439, 1441]; W of Matano village, near Danau Matana, 15-16 Sep 1993, 6 males (M.T. Wasscher) [JvT

16710, 16713, 16716, 16717, 16725, 16789]; 5 km S of Soroako, forest stream, 25 Sep 1993, 3 males (M.T. Wasscher) [JvT 16747-16748, 16758]; Palopo, km 17, 400 m, 11 May 1941, 3 males 1 female (H. & E. Vonk); 10 km NW Palopo, Salo Tandung, c. 400 m, 2°58'S 120°07'E, 91JvT015, 27 Apr 1991, 9 males 1 female (J. van Tol) [JvT 5145-5154]; 10 km WNW Palopo near Tojambu, 800- 1000 m, July/August 1991, 13 males 3 females (Yohan R.) [JvT 11800-11802, 11873-11885]; W of Sabbang, tributary of Sg Ronkong, 150-200 m; 2°36'00"S 120°12'45"E, 3 males (J. van Tol) [JvT 1702-1704]; Masamba, inland, 2°30'S 120°25'E, 1-2 Nov 1993, 9 males (Yohan R.) [JvT 2035-2043, 16790-16791]; NW Palopo, tributary of Sg Lamasi, 2°51'15"S 120°06'15"E, 2 Nov 1993 (J. van Tol) [JvT 1715]; Tojambu area, 7 males 2 females (Gala) [JvT 16361-16369]; 20 km NW Palopo, Sg Lowi, 2°51'00"S 120°04'45"E, 4 males 3 females (J. van Tol) [JvT 1718- 1724]; Bonthain, Malino, 1000 m, 29 Jun 1936, 5 males, 3 females (L.J. Toxopeus) [JvT 1847, 1848, 1851-1856]; S. Celebes, Lompa-Battau, 3000', März 1896, 1 male (H. Fruhstorfer) [JvT 1850]; Celebes [no further details, ex Museum Paris], 1 male [JvT 1849]. – **Buton**: N. Pulau Buton, a few kms inland from Labuhan Tobelo, Sg Labuhan Tobelo, 150 m, 4°26'30"S 122°59'E, 89JvT040, 13 Nov 1989, 4 males (J. van Tol) [JvT 1925-1928], all in RMNH, except given otherwise; part of the series from Masamba, Tojambu and Sanggona will be deposited in MBBJ.

Description

Variable species or a complex of microspecies. The species in the present sense encompasses virtually all specimens with inferior appendages in ventral view as a 'boxing glove' (Fig. 20), i.e. with a strongly swollen tip and a slender, inwards pointing inner-tooth close to the top. Several populations of the *geijskesi* species- group from the southwestern-most part of the island are considered distinct, and are here described as *Protosticta pariwonoi*.

Male [holotype, JvT 1923]. – Head. Labium yellowish brown, anterior part of median lobe and palps brown; labrum bluish white, anterior one-fifth to one-fourth black; mandibles black to brownish black, dirty white against labrum, otherwise completely black; anteclypeus bluish white; postclypeus and remaining part of head shining black; antenna with scapus brownish black, pedicellus and flagellum brown (flagellum broken off in holotype).

Thorax. Pronotum (Figs 58-59) with anterior and median lobe predominantly creamish white, posterior lobe black; anterior margin of anterior lobe with transverse ridge; posterior lobe with hind margin somewhat raised into a short subtriangular 'horn'. Synthorax (Fig. 80) with mesepisternum without antehumeral stripe, generally glossy brownish black without metallic shine; pale stripe over mesepimeron and metepisternum and over lower side of metepimeron; pale coloured fascia anterior to metapleural suture anteriorly passing to brownish black well before metakatepisternum. Legs dirty yellowish, somewhat darker against joints. Wing length 24 mm; reaching to one-third of abdominal segment 6; Arculus distal to Ax2; origin of R4+5 at subnodus; five cells between origin of IR3 and R3; six to seven cells between Cux (Ac) and place where CuP meets hind margin of wing.

Abdomen. Length including appendages 38 mm. Slim and slender with segments 1-2 somewhat inflated, segments 8-10 distinctly swollen; segment 1 creamish white with narrow posterior brown ring; dorsum of segment 2 dark brown, lateral sides passing to yellowish white; dorsum of segments 3-7 brown, segments 4-6 anteriorly with dorsal brown marking laterally tapering, thus forming an antero-lateral pale spot; dorsum of tergites 8-9 blue (Fig. 17), segment 8 with medio-anterior triangular marking, and also with postero-lateral black markings, margins of segment 9 black; segment 10 black. Anal appendages (Figs 17-19) with superiors curved moderately inwards, with indistinct dorsal process from c. 1/4 from base onwards, extending just beyond half-length from base, top simple without scythe-like wide part; inferiors converging in basal half, distal part more slender and diverging, tip sharply curved inwards and approximately perpendicular to body axis; tip swollen as a 'boxing glove' (Fig. 20), innertooth ('thumb') rather short and pointing somewhat antero-dorsadly.

Female [JvT 1718, 20 km NW Palopo]. – As the male, but abdomen much shorter. Head as male, but mandibles pale coloured (bluish or creamish); pronotum as male, but 'horns' at posterior lobe more distinct, approximately as long as height of posterior lobe; segment 1 of abdomen creamish

white, lateral sides of tergites creamish; segments 2-7 dorsally brownish black, anterior one-fourth to one-fifth paler; segment 9 dark brown with large oval, creamish coloured latero-posterior spot on tergite, not quite reaching ventral and posterior margin (Fig. 92); segments 8-10 in dorsal view (Fig. 100) nearly completely dark, the pale spots only just visible laterally; segment 10 short; valves (Fig. 92) long, reaching distinctly beyond appendages, stylus long and slender.

Variation. – Much variation in measurements, shape of prothorax, and shape of anal appendages. Hind margin of prothorax with erect parts of hind margin long or short. The inferior appendages with tips round to oval of various sizes, and with the 'thumb' from a relatively stout (Fig. 20) to a nearly filamentous tooth. Specimens from the Lompobatang mountain (Malino, Bonthain) are large, do not possess 'horns' on the hind margin of the prothorax, but the anal appendages of the male are clearly different from *P. pariwonoi* males, and come closest to *P. geijskesi.* The precise relationships and status of the populations here lumped under the names of *P. geijskesi* and *P. pariwonoi* should be studied when more material has become available, especially from the southwestern peninsula.
Measurements. – Much variation between populations. Males: Buton (n=4) abdomen (including appendages in all measurements given) 40 (39-41) mm, hind wing 26 (25-27) mm; Mokowu (n=5) abdomen 41 (39-41) mm, hind wing 25 (25-26) mm; Luwuk (n=5) abdomen 39 (38-41) mm, hind wing 25 (24- 27) mm; Kolonedale (n=3) abdomen 37 (34-40) mm, hind wing 23 (22-25) mm; NNE Malili (n=4) abdomen 39 (38-40) mm, hind wing 24 (23-25) mm; Baebunta (n=1) abdomen 33 mm, hind wing 21 mm [sic!]; Madjene (n=2) abdomen 41 mm, hind wing 27 (27-27) mm; NW Palopo (n=5) 40 (39-41) mm, hind wing 26 (26-27) mm; Lompobatang (n=7) abdomen 44 (42-46) mm, hind wing 29 (28-30) mm.

Remarks

Etymology. – *Geijskesi*, after my teacher, colleague and friend Dirk Cornelis Geijskes (1907-1985), former curator at the National Museum of Natural History, Leiden.
Habitat. – Not uncommon in lowlands, where it is the dominant species; much less common above 500 m, but also found on Gunung Watuwila (c. 1000 m), and Gunung Lompobatang (unknown altitude). Records are from various kinds of streams, mostly small streams in half-shade, to forest rivulets of several meters wide. *P. geijskesi* is less common on spring brooks in dense shade. It has also been found in semicultivated areas, and severely disturbed forest. Females are very uncommon in collections. I found only two females among 70 males at the foothill stream of Gunung Watuwila.
Distribution (Fig. 112). – Widespread in central and southeastern Sulawesi; not recorded from most of the northern peninsula (Gorontalo, Minahasa), and also absent from the mountainous areas between Palu and Rantepao (e.g. Lore Lindu National Park). In the southwestern peninsula it is uncommon. A larger form, here assigned to *Protosticta geijskesi*, has repeatedly been collected on the slopes on Gunung Lompobatang. A closely related species, *P. pariwonoi*, is inhabiting the lowlands of this presently severely disturbed area.

Protosticta gracilis Kirby

(Figs 22-25, 60-61, 81, 107, 111)

Protosticta gracilis Kirby, 1889: 302. – Holotype male 'Menado Wallace' [white rectangular label], 'Tond.' [white round label], '68.3' [white rectangular label] '*Protosticta gracilis* type' [blue rectangular label, Kirby's hand] in BMNH [examined]. – Kirby 1890: 133 (catalogued); Kimmins 1970: 174 (list of types in BMNH); Davies & Tobin 1984: 107 (catalogued); Tsuda 1991: 8 (catalogued); Bridges 1994: VII.100 (catalogued).

Description

A stout and robust species of *Protosticta*.
Male [holotype]. – Head. Labium creamish yellow at base, labial palps and remaining part of labium brown; mandibles creamish yellow with anterior border with narrow brown stripe; labrum creamish white, anterior one-third brownish black; anteclypeus creamish white; postclypeus brownish black; remaining part of head

semi-glossy brownish black with two paler spots next to lateral ocelli.
Thorax. Pronotum (Figs 60-61) matt; median lobe ochraceous; anterior lobe, especially in centre, somewhat darker, central part protruding with hind margin of middle part reverse V-shaped, lateral parts erect; posterior lobe black without conspicuous latero-posterior lobes ('horns'). Synthorax (Fig. 81) brownish black, mesepisternum without antehumeral stripe; creamish yellow fascia over metepisternum; ventroposterior side of metepimeron creamish white. Legs pale brown, joints somewhat darker. Wings with dark veins; R4+5 arising significantly proximal to subnodus (Fig. 107); IR3 arising only 1/6th to 1/4th of length of a cell distal to subnodus; CuP reaching hind margin of wing at level of R3, ten cells between Cux and place where CuP meets hind margin of wing; fore wing with 21 or 22 Px, hind wing with 18 Px.
Abdomen. Dorsum of segment 1 anteriorly with pale brown crescent-shaped marking, remaining part of segment 1 and segments 2-7 brown to brownish black, somewhat darkening posteriorly; anterior onesixth of segment 8 brownish black, remaining part of segment 8 and segment 9-10 blue (Fig. 21). Anal appendages (Figs 21-25) black; superiors in dorsal view with a subconical basal part with underside hollow, ending in a short, glossy tooth; distal part of superiors curved inwards, ending in a flattened disc (Fig. 23); inferiors with ventral side semi-glossy, distal part straight with top curved 90° inwards, at c. one-third from the base a strong, very long and somewhat dorsadly curved tooth with a transverse brownish yellow band over terminal part of main stem.

Female. – Unknown.
Measurements – Male (n=1) abdomen (including appendages) 43 mm, hind wing 30 mm.
Comparative notes. – Similar to *P. coomansi*, from which it mainly differs by the structure of the anal appendages of the male. See further under *P. coomansi*.

Remarks
Habitat and distribution (Fig. 111). – The only specimen known was collected by A.R. Wallace, almost certainly at Tondano, northern Celebes. Wallace collected in the vicinity of Tondano (Rurukan) in late June and early July 1859 (see Wallace 1890 [1962]: 193). He actually stayed at Tondano a few days after 29 June, so early July, only. He visited the waterfalls at the outlet of the lake, where probably the present specimen was taken. The area is now completely cultivated (own observations). Although the Minahasa, especially the easternmost part around Menado, was well explored in the 1930's and 1940's, the species has not turned up on any of these sites.

Protosticta linduensis sp. n.
(Figs 26-29, 62-63, 82, 112)

Type material. – Holotype male: 'Celebes, Polewali, 23 Oct 1940, J.J. van der Starre' [identified as *Protosticta* spec. H by M.A. Lieftinck] [JvT 1857] in RMNH. – Paratypes: Same data, 1 male [JvT 1858]; 10 km WNW Palopo, river above km 23 from Palopo. 800 m. 2°56'S 120°07'E. July/Aug 1991, 2 males (purchased from native collector Yohan R.) [JvT 1859, 1860]; 50 km SE Palu: Lore Lindu NP nr Dongi Dongi shelter, 950 m, 9 Dec 1985 sample A, 1 male (J. van Tol) [JvT 1861]; W. of Palopo: Tojambu, 2 Nov 1993, 1 male (Gala) [JvT 16360]; Lore Lindu NP, Kamarora, 01°11'53"S 120°08'16"E, 1 male (J. van Tol) [JvT 16644] all in RMNH, but one male from Palopo in MBBJ.

Description
Moderately large species with remarkable, broad anterior lobe of prothorax and very slender anal appendages.
Male [holotype, JvT 1857]. – Head. Labium dark yellow; labrum blue with brownish anterior border; anteclypeus yellow, pale but not concolorous with labium; postclypeus and remaining part of head black; antennae black.
Thorax. Pronotum (Figs 62-63) with anterior lobe laterally with scale-like expansions, central part brown and lateral parts ochraceous; median lobe pale yellowish white without distinct characters; posterior lobe brownish black with lateral corners acute, hind margin nearly straight with shallow (specimens from Polewali), or more distinct (specimens from Dongi Dongi) emarginations. Synthorax (Fig. 82) chestnut brown, somewhat darker between

mesopleural (humeral) sutures; bluish yellow fascia over mesepimeron and metepisternum running anterior to metakatepisternum over metastigma, leaving the metapleural suture, ending against hind margin midway between humeral and metapleural suture; subequal dark stripe over metapleural suture parallel to pale fascia; remaining ventro-posterior part of metepimeron brownish yellow. Legs greyish with joints of femur to tibia somewhat darker. Wings (26 mm) reaching halfway abdominal segment 6; Arculus well distal to Ax2; origin of R4+5 at or proximal to subnodus; 5-6 cells between origin of IR3 and R3; 6-8 cells between Cux (Ac) and place where CuP meets hind margin of wing.
Abdomen. Length including appendages 40 mm. Segments 1-2 considerably inflated, segments 8-10 strongly inflated; segment 1 creamish white, segment 2 pale brown with latero-anterior two-thirds brownish yellow; segment 3-7 anteriorly with pale ring, followed by a brown ring passing to brownish yellow in posterior parts, each segment posteriorly with dark ring; segment 8 with anterior one-fourth brown, remaining part blue surrounded by brownish black ring; segment 9 blue on dorsum; segment 10 brownish black (Fig. 26). Anal appendages (Figs 26-29) slender; superiors smoothly curved ventro-proximad, dorsal tubercle triangular, not sharp as in most other Sulawesi species; inferiors shorter, strongly curved inwards, the inner subterminal tubercle ('thumb') long and curved inwards (cf. Fig. 29).
Female. – Unknown.
Measurements. – Male (n=5) abdomen including appendages 40-41 mm; hind wing 26-27 mm.

Variation. – The anterior lobe of the pronotum is dark brown or pale; the structure of the anterior lobe of the pronotum shows variation; especially the specimen from Kamarora (JvT 16644) has a conspicuously wider and more erect hind margin than other specimens.

Comparative notes. – Although *P. linduensis* is superficially similar to *P. geijskesi*, the peculiar shape of the anterior lobe of the prothorax is diagnostic. Moreover, the dorsum of abdominal segment 8 is only blue in the distal 50-70%, while it is completely blue in *P. geijskesi*. It is most closely related to *P. marenae* sp. n., in which, however, the anterior lobe of the prothorax is much less widened laterally. Also, the top of the inferior appendage is much more slender in *P. linduensis* than in *P. marenae* (compare Figs 28 and 32, which are drawn to scale).

Remarks
Etymology. – *Linduensis*, after one of the localities, the Lore Lindu National Park, Central Sulawesi.
Habitat. – All specimens collected by myself were found in dense forest. The specimen from Dongi Dongi was found hanging along a foothill brook with only a few centimetres of water flowing through a steep and narrow ravine in (at that time) hardly disturbed tropical rain forest. Only one specimen was discovered between numerous examples of *Protosticta coomansi* sp.n.
Distribution. – Geographically western Central Sulawesi (politically partly Southwestern Sulawesi) (Fig. 112).

Protosticta marenae sp. n.
(Figs 30-33, 64-65, 83, 93, 101, 112)

Type material. – Holotype male: S of Palu, Gimpu, 450 m, 1°40'46"S 120°03'30"E, 2 Apr 1997, 1 male (J. van Tol) [JvT 16579]. – Paratypes 9 males 1 female: Central Sulawesi, 65 km SSE Palu: Lore Lindu NP nr Marena shelter, 600 m, 14 Dec 1985 sample B, 2 males (J. van Tol) [JvT 1862-1863]; same locality, 15 Dec 1985 sample B, 2 males (J. van Tol) [JvT 1864- 1865]; same locality, 16 Dec 1985 sample C, 2 males (J. van Tol) [JvT 1866-1867]; close to previously mentioned locality: foothill brooklet nr Anaksungai Mbewe, alt 700 m, 17 Dec 1985 sample B, 1 male (J. van Tol) [JvT 1868]; S of Palu, Gimpu, 450 m, 1°40'46"S 120°03'30"E, 2 Apr 1997, 2 males 1 female (J. van Tol) [JvT 16580, 16581, 16583]. All specimens in RMNH, but 2 males to be deposited in MBBJ.

Description
Medium-sized species, characterized by shape of anterior border of prothorax, horn-like structures at posterior margin of prothorax, shape of inferior appendage of male (Fig. 33), and black dorsum of abdominal segment 10.

Male [holotype, JvT 16579]. – Head. Labium brown; labrum bright creamish white with medio-anterior two-fifths black, laterally tapering in width; mandibles black with only inner base pale coloured; anteclypeus bright creamish white; postclypeus and remaining part of head black. Antennae brownish black.
Thorax. Pronotum (Figs 64-65) with anterior lobe dark brown, except for a longitudinal yellowish stripe close to lateral corners, shaped as long dish with raised borders, characteristically 'V'-shaped in cross-section, laterally somewhat wider than centre; median lobe yellowish, with two low tubercles; posterior lobe black with bluish metallic shine, lateral corners tapering into slender, laterally pointing processes perpendicular to body axis. Synthorax (Fig. 83) base colour black, in most specimens with metallic shine; metepisternum with parallel-sided greenish-white coloured fascia parallel to metapleural suture, with lower side over metastigma, posteriorly tapering towards interpleural suture; dark fascia over metapleural suture dark brown to black, somewhat wider than pale fascia anterior to it; remaining part of metepimeron creamish white. Legs greyish, joints somewhat darker. Wing length 24 mm; wings reaching just beyond abdominal segment 5, origin of Arculus distal to Ax2; origin of R4+5 at or even distal to subnodus; five cells between origin of IR3 and R3; seven cells between Cux and place where CuP meets hind margin of wing.
Abdomen. Length including appendages 38 mm. Brownish, relatively pale, with first segment creamish, segments 2-6 brown on dorsum except for posterior dark brown one-sixth part, latero-anteriorly with creamish white spots, segment 7 dark brown except for latero-anterior creamish spots; segment 8 with dorsoanterior one-fifth and lateral sides brownish black, remaining part blue; segment 9 with dorsum blue, lateral sides brownish black; segment 10 black. Appendages (Figs 30-33) brownish black; superiors smoothly curved ventro-proximad, distal half flattened but not conspicuously wider than base, c. half-way with triangular tubercle; inferiors in ventral view smoothly curved outwards from base, with top curved inwards, tip strongly tapered and curved dorsadly, subterminal inner-tooth short and rather bluntly shaped.

Variation. – No apparent variation in structural details in the type series.

Female [JvT 16580, Gimpu]. – General coloration similar to male, but head with mandibles bluish white; pronotum with anterior lobe markedly different, and not conspicuously widened, only simply thickened, remaining part similar to male; abdomen with pale markings of segments 2-7 more pronounced than in male, segment 8 short, dark brown, with large creamish spot latero-anteriorly against margin of tergite; segment 9 brownish black with large paired lateral spot not touching in dorsal view and not touching margin of tergite; segment 10 brownish black, valve straight and long, reaching far beyond segment 10.
Remark: Some doubts remain whether this specimen indeed represents the female of *P. marenae* sp. n. Especially the anterior lobe of the pronotum differs more from the male than noted in other species.

Measurements. – Males (n=7) abdomen including appendages 37 (36-37) mm; hind wing 24 (23-24) mm.
Comparative notes. – Based on the shape of the inferior appendages, the largely black mandibles, and a black dorsum of abdominal segment 10 similar to *Protosticta geijskesi* sp. n. Presumably sistertaxon of *Protosticta linduensis* sp. n., a relationship that is especially apparent by the shape of the anterior lobe of the prothorax. It is, however, much smaller than *P. linduensis*, and especially the tip of the inferior appendage is much smaller. Also, *P. linduensis* has the lateral sides of the anterior lobe of the pronotum more conspicuously enlarged, and the distal half of the superior appendages widened.

Remarks

Etymology. – *Marenae*, after the shelter 'Marena' near the type locality close to the Lore Lindu National Park.
Habitat. – Found along rather shallow brooklets through relatively open, somewhat disturbed rain forest. Other species on these sites included *Protosticta coomansi* sp. n. and *Disparocypha biedermanni* Ris.
Distribution. – Central Sulawesi (Fig. 112). Only

known from two sites close together, and certainly not common or widespread in the area.

Protosticta maurenbrecheri sp. n.

(Figs 34-36, 66-67, 84, 110)

Type material. – Holotype male: 'Sulawesi, c. 10 km NW Palopo (km 15 road Palopo-Rantepao): Salo Tandung, c. 400 m asl. Width 10 m, large boulders, torrents, seepage areas. Rather open secondary forest overhanging from bank, otherwise not shaded. c. 2°58'S 120°07'E. 27 Apr 1991. Sample 91JvT15. Leg. J. van Tol' [JvT 1869] in RMNH. – Paratypes 4 males: C. Celebes (Loewoe), Masamba, S. Baeboenta, 17 Apr 1940, 12 May 1940, 25 May 1941, 4 males (L.L.A. Maurenbrecher) [JvT 1870-1873] (in RMNH). Several of the paratypes are in poor condition due to damage by psocids. Specimens collected by Maurenbrecher labelled by Lieftinck as *'P. bivittata*'.

Description

Rather robust species; immediately recognizable by the presence of a pale antehumeral stripe of synthorax, in combination with a bilobed hind margin of the anterior lobe of the prothorax.

Male [holotype, JvT 1869]. – Head. Labium at base ochraceous, median lobe and palps chestnut-brown; mandibles bluish yellow to ochraceous, not concolorous to labrum; labrum bluish white with anterior onefourth to one-third with parallel-sided black stripe; anteclypeus concolorous with labrum; postclypeus and remaining part of head brownish black to black; scapus and flagellum brown; pedicellus dirty yellow.

Thorax. Pronotum (Figs 66-67) with anterior and median lobe bright creamish white, posterior lobe brownish black; anterior lobe with anterior transversal ridge much narrower in the centre than at lateral sides, widest part brownish covered with very short spiny setae, hind margin bilobate, shortly erect; median lobe without distinct characters; posterior lobe flat, hind margin nearly straight, but with lateral triangular process curved outwards. Synthorax (Fig. 84) chestnutbrown, ventrally somewhat paler, with brightly bluishwhite coloured lateral fasciae; antehumeral stripe close to dorsal carina narrowing posteriorly, ending well before hind margin of synthorax; pale, parallel-sided stripe over mesepimeron and metepisternum relatively wide and running parallel to metapleural suture, anteriorly just reaching mesokatepisternum, not covering metakatepisternum; ventral pale coloration of metepimeron widening posteriorly. Legs greyish yellow, joints brown. Wings nearly reaching posterior margin of abdominal segment 5; Arculus just distal to Ax2, origin of R4+5 approximately at subnodus; five cells between origin of IR3 and R3; seven cells between Ac (Cux) and place where CuP meets hind margin of wing; pterostigma nearly rectangular.

Abdomen. Segment 1 dorsal side ochraceous, lateral side yellowish; segment 2-6 dorsally predominantly ochraceous, anteriorly (especially latero-anteriorly) much paler, nearly creamish white, and posterior onefifth to one-sixth of each segment chestnut-brown to brownish black; segment 7 dark brown with anterior one-fourth dirty yellow; segment 8-10 dorsally blue, latero-posterior sides of tergites 8-9 black, lateral side of segment 10 black. Anal appendages (Figs 34-36) black; superiors rather slender with large dorsal tooth at c. two-fifth from the base, length of tooth approximately equal to diameter of appendix, insignificant ventral process at c. one-third from the top; inferiors with sturdy base, the more slender terminal parts curved outwards, near the top sharply curved inwards; top oblong triangular with inner-tooth very small in comparison to other species.

Female. – Unknown.

Measurements. – Male abdomen including appendages for specimens from Masamba (n=4) 41 mm, specimen from Palopo 47 mm; hind wing for specimens from Masamba 23 mm, the specimen from Palopo 25 mm.

Comparative notes. – Easily distinguishable from other Sulawesi *Protosticta* species by the presence of an antehumeral stripe, its considerable size, and the bilobate hind margin of the anterior lobe of the prothorax. It is similar in general appearance to *P. bivittata* , but it lacks the 'inner-horns' at the hind margin of the posterior lobe of the prothorax, and the strong inner-tooth of the inferior appendix (cf. Fig. 9).

Remarks

Etymology. – *Maurenbrecheri*, after Mr. L.L.A. Maurenbrecher, who collected odonates on Sulawesi in the 1940's for M.A. Lieftinck.

Habitat. – The type was found hanging in shrubs along a rivulet through semi-cultivated area at c. 400 m above sea level. Only one specimen was found among ten specimens of *Protosticta geijskesi* sp. n., a common lowland species in that region. Sungai Baebunta near Masamba is also a lowland locality, now situated in cultivated area. My own efforts in this area have not revealed any specimen of this beautiful species.

Distribution. – Central Sulawesi (politically Southwest Sulawesi), south of the central mountain ranges (Fig. 110).

Protosticta pariwonoi sp. n.

(Figs 37-39, 68-69, 85, 94, 102, 112)

Type material. – Holotype male: 'Indonesia, Sulawesi / E. of Maros: Bantimurung area, Sg. / Pattunuang Asue. Fast flowing stream / through disturbed forest on limestone. Large / boulders, ponded areas, clear water / 5°03'S 119°41'E. Sample 91JvT07 / 17 and 20 Apr 1991 / Leg. J. van Tol' in RMNH [JvT 5241]. – Paratypes: SW Celebes: Maros, Patunuang Asue, 23, 24, 25 Sep 1983, 4 males 1 female (S.S. Pariwono) [JvT 5230-5233, 5256, 5261]; Maros, Bantimurung, Biseang Labboro, 7, 8 and 10 Oct 1983, 6 males 3 females (S.S. Pariwono) [JvT 5234-5240, 5258-5260]; E of Maros, Bantimurung Area, Sg. Pattunuang Asue. 5°03'S 119°41'E. Sample 91JvT07, 17 and 20 Apr 1991, 5 males 1 female (J. van Tol) [JvT 5241-5244, 5252, 5257]; c. 30 km E of Maros, Cakar Alam near Desa Layia. Sg. Labang, and tributary. c. 5°00'S 119°50'E. 91JvT10 and 91JvT11. 20 Apr 1991, 10 males (J. van Tol) [JvT 5245-5251, 5253- 5255] all in RMNH, but 3 males and 1 female to be deposited in MBBJ.

Description

Relatively robust and large species, with similar general appearance as *Protosticta geijskesi*, but with much larger and also otherwise differing inferior appendages (see Fig. 39); anterior margin of prothorax wider than in *P. geijskesi*.

Male [holotype, JvT 5241]. – Head. Labium greyish white, tips of palps darker, brown; labrum bluish white, anteriorly with a narrow brownish black band; mandibles shiny black except for a paler spot in the basal corner against the labrum; anteclypeus bluish white; postclypeus and remaining part of head black; antenna concolorous brown (flagellum of right antenna broken).

Thorax. Pronotum (Figs 68-69) with anterior lobe brown, posterior lobe brownish black; anterior margin of anterior lobe curved distad, corners somewhat less than centre; sides conspicuously swollen; median lobe pale yellow; posterior lobe with raised hind margin and two 'horns' curved apicad; much variation in size of horns. Synthorax (Fig. 85) dark brownish black, black between humeral sutures, with parallelsided pale stripe parallel to metapleural suture running over mesepimeron and metepisternum touching metastigma; metepimeron creamish white with brown marking against metapleural suture rectangular at ventral side, pointed dorsally. Legs greyish brown. Wing length 25 mm; wings with origin of Arculus half the length of Ax2 distal to Ax2; origin of R4+5 at subnodus; nearly six cells between origin of IR3 and R3; six to seven cells between Ac (Cux) and place where CuP meets hind margin of wing.

Abdomen. Length including appendages 38 mm. First segment dark yellow with posterior brown ring; second segment brown with subrectangular latero-anterior marking; segments 3-6 dorsally brown, leaving anteriorly a creamish white ring and posteriorly passing to brownish black; segment 7 brownish black with latero- anteriorly an ovoid yellow marking; segments 8 and 9 blue on dorsum, only with minor brownish black markings in latero-distal corners; segment 10 black. Appendages (Figs 37-39) with superiors dark brownish black, slender; dorsal triangular process at approximately three-fifths from base, also an inconspicuous process at innerside at approximately four-fifths from base; inferiors in ventral view distal half with slender base and top as well-developed 'boxing glove', thumb thin and slender, connected by membranaceous (chitinized) structure; outer tip acute and somewhat curved inwards.

Female. – As the male, but mandibles creamish white, not black as in male (similar to *P. geijskesi*); anterior lobe of prothorax with anterior margin not laterally

flattened as in male, although somewhat produced and erect; inner horns of hind lobe of posterior lobe of prothorax slender. Abdomen much shorter than male; segment 2 narrowest segment, abdomen gradually widening posteriorly; segment 1 creamish white except for dark crescent shaped dorso-posterior marking; segment 2 dark on dorsum with pale coloration in ventro-anterior three-quarters towards sternites; segments 3-7 with dorsum brownish black, gradually paler towards sternites, with pale anterior twinspot leaving anteriorly a median dark dorsal stripe; tergite 8 (Fig. 102) dorsally brownish black with creamish white marking in latero-anterior threequarters, sternite 8 pale creamish white, base of valve segment 8 pale creamish white, top black; segment 9 dark brownish black, laterally with pale central oval spot, valve (Fig. 94) of segment 9 dark, top of terebra pale coloured except for black dorsal line, stylus long and slender; segment 10 dark.
Variation. – There is some variation in the length of the 'horns' at the hind margin of the prothorax.
Measurements. – Male (n=23) abdomen including appendages 39 (36-42) mm, hind wing 26 (24-28) mm; female (n=5) abdomen including appendages 33 (31-35) mm, hind wing 24 (23-25) mm.

Comparative notes. – Very similar to *P. geijskesi* (see key for characters), confined to the southernmost part of the southwestern peninsula of Sulawesi. The much more robust top of the inferior appendage and the swollen sides of the anterior lobe of the prothorax are diagnostic characters; in most specimens also the shape of the hind margin of the prothorax with 'horns' distinctly different from specimens here assigned to *P. geijskesi*. Specimens from Gunung Lompobatang (SW Sulawesi) above c. 1000 m, although much larger than specimens from populations in Central and Southeastern Sulawesi, are assigned to *P. geijskesi*.

Remarks
Etymology. – Named after Scipio S. Pariwono (born 1919 in Gorang Gareng, Eastern Java, mainly lived in Bogor, Indonesia) (formerly named Liem Swie Liong), a former assistant to A.M.R. Wegner at Nongkodjadjar and A. Diakonoff in MBBJ. Through numerous field trips, mr. Pariwono has contributed significantly to our knowledge of the Odonata of Indonesia, especially of Java, Borneo and Sulawesi. Mr. Pariwono made collecting and reconnaissance trips to Sulawesi with M.A. Lieftinck in 1982, and with J. van Tol in 1989.
Habitat. – Own records pertain to specimens collected around Bantimurung, where this species is not uncommon along rivulets through rather open, somewhat disturbed riverine forest on limestone. *Protosticta bivittata* is another species reported from this area, but that species is less common, and presumably also more seasonal. *P. pariwonoi* was also observed along a tributary of one of the streams, which was flowing through dense forest, where the most common species was *P. coomansi*.
Distribution. – Only known from the extreme southwest of Sulawesi (surroundings of Maros, Bantimurung) (Fig. 112).

Protosticta reslae sp. n.
(Figs 40-42, 70-71, 86, 111)

Type material. – Holotype male: 'Celebes. Polewali 6/8/40 [= 6 Aug 1940]. J.J. van der Starre' and '*Protosticta* spec. nov. E' [Lieftinck's hand] [JvT 1876] in RMNH. – Paratype 1 male: Same envelope as holotype, 1 male [labelled as paratype] [JvT 1877] in RMNH.

Description
Robust species, with inferior appendage stoutly built, and superior appendage relatively broad.
Male [holotype, JvT 1876]. – Head. Labium with palps and anterior side of median lobe dark brown, remaining part pale brown; mandibles bluish white with anterior one-fourth brownish black; labrum bluish white, with anterior one-fourth with a parallelsided black stripe; anteclypeus bluish white as labrum, postclypeus and remaining part of head black; area below antennae and median ocellus glossy, dorsal surface velvet black.
Thorax. Pronotum (Figs 70-71) with anterior lobe brown, relatively narrow, anterior and posterior margin parallel-sided with an irregular, transverse ridge partly running along anterior margin; median

lobe dirty greyish white (? due to preservation); hind lobe brownish black, simply built with lateral corners only somewhat curved upwards. Synthorax (Fig. 86) brownish black with metallic shine; no antehumeral stripe; creamish fascia over metepisternum straight on anterior side, but with irregular ventro-posterior margin, fascia wide over stigma, constricted just above stigma; dark stripe over metapleural suture extending to halfway metepimeron, posteriorly tapering towards suture; remaining part of metepimeron creamish white. Wing length 32 mm; Arculus just distal to Ax2, origin of R4+5 well proximal to subnodus; seven cells between origin of IR3 and R3; eleven cells between Ac (Cux) and place where CuP meets hind margin of wing. Abdomen. Length including appendages 45 mm. Slender, brown and paler than most other species of Sulawesi. Segments 1-2 relatively little swollen, segments 8-10 strongly inflated, segment 7 setose on dorsal side; segment 1-7 with inconspicuous coloration, segment 1 brown with somewhat paler centre, segments 2-7 concolorous brown, although somewhat darker against hind margin of each segment; distal 7/8th of dorsum of segment 8, and segment 9-10 with blue marking (obscured by post mortem changes in the types) . Appendages (Figs 40-42) with superiors brownish black, in dorsal view a blunt dorsal toothlike tubercle at 3/4th from base, scythe-shaped terminal part extending for three-quarters of the distal part of superior, stronger developed than in *P. coomansi*. Inferiors also dark brown, structure of top comparable to *P. coomansi*, but inner tooth stronger developed.
Female. – Unknown.
Measurements. – Paratype wing length 32 mm, abdomen including appendages 48 mm..

Comparative notes. – Similar to *P. coomansi*, based on shape of inferior appendage and blue marking of abdominal segment 10. It can be distinguished from *P. coomansi* and *P. gracilis* by the shape of the superior and inferior appendages of the male. The superior appendage is robust and scythe-shaped, with a blunt dorsal tooth in the distal half (Fig. 40). Inferior appendage in ventral view rather similar, but more robust than in *P. coomansi* (Fig. 42).

Remarks
Etymology. – *Reslae*: a combination of characters, in which the abbreviation of the Royal Entomological Society of London (RESL) can be detected. The RESL was the organizer of Project Wallace (Dumoga Bone National Park, northern Sulawesi) in 1985, which formed the immediate reason for me to start a study on the Odonata of Sulawesi.
Distribution. – Only known from the type locality Polewali in the topographically southwestern part of central Sulawesi (Fig. 111).

Protosticta rozendalorum sp. n.
(Figs 43-46, 72-73, 87, 95, 103)

Type material. – Holotype male: 'Indonesia, Sangihe Islands: NW slope of Gunung Sahendaruman (SSW of Liwung): 2˚32'N 125˚32'E. Primary forest and forest edge, water trickle and small streams. 600- 650 m. 12-19 May 1985' (type actually collected 19 May 1985) (F.G. Rozendaal) [JvT 1879] in RMNH. – Paratypes: Same site (one without proper label), 14 and 19 May 1985, 2 males 1 female (F.G. Rozendaal) [JvT 1880-1882]; Manganitu, riverine gardens, coconut, plantations, secondary growth, 3˚35'N 125˚32'E, 10 May 1985, 1 male (F.G. Rozendaal) [JvT 1878] all in RMNH.

Description
Medium-sized species, which is not closely related to any of the species occurring in Sulawesi. Immediately distinguishable from other *Protosticta* treated in this paper by the shape of the inferior appendages of the male.
Male [holotype, JvT 1879]. – Head. Labium dark creamish white, labial palps brown; mandibles with anterior side variable in colour, brown or pale; labium bluish white with a black stripe along the anterior margin, c. one-third the height of labium, with basiomedial V-shaped emargination; anteclypeus creamish white; postclypeus and frontal part of head glossy black; dorsal surface of head velvet black. First segments of antenna brown, flagellum brownish black. Thorax. Pronotum (Figs 72-73) with anterior lobe black, shape rather simple with anterior margin with rim, median lobe brownish black, lateral tubercles only little elevated, posteriorly brown; hind lobe black, flat without erect parts. Synthorax (Fig. 87) brownish black

with pale parts creamish; antehumeral stripe absent; fascia over mesepisternum nearly par- allel-sided, only tapering dorso-posteriorly; dark stripe over metapleural suture with sharp outline on metepimeron, where somewhat irregular. Legs greyish. Wing length 26 mm; pterostigma pale bordered against veins, most narrow anteriorly against Costa; Arculus just distal to Ax2, origin of R4+5 at or just anterior to subnodus; five cells between origin of IR3 and R3; nine cells between Ac (Cux) and place where CuP meets hind margin of wing.

Abdomen. Length including appendages c. 40 mm. Rather slender, only segments 9-10 somewhat inflated; segment 1 creamish yellow with dorsum pale brown and a posterior dark brown ring; segment 2 brown with latero-anterior two-thirds of tergite creamish yellow; segment 3 brown, much darker posteriorly and a latero-anterior creamish yellow marking; segments 4-7 brown, somewhat darker posteriorly and a latero-anterior creamish yellow marking on each segment; segment 8 with posterior 5/6th of dorsum pale blue, anteriorly and laterally bordered with dark brown, ventral part of tergite creamish; segment 9 with dorsum pale blue, ventral part brownish black; segment 10 brownish black. Appendages (Figs 43-46) brownish black; superiors smoothly curved inwards, innerside halfway with triangular tooth directed ventrad, at approximately three-quarters from base a low tubercle at base of an elongate emargination to the top; inferiors in ventral view with basal half straight, then pointed 90˚ outwards, and then again directed posteriad; top smooth and shining, in ventral view a subquadrangular structure with short basal innertooth, in dorsal view consisting of a terminal hook with a subterminal innertooth, which are connected by a delicately chitinized veil.

Variation. – No notable structural variation in paratypes.

Female. – As the male, but mandibles pale coloured, abdominal segment 8 short, dorsum dark brown, gradually paler towards sternites; segment 9 anteriorly and posteriorly dark brown, also centre of dorsum dark brown, lateral sides with much paler brownish coloured markings; segment 10 dull castaneous; valves long, projecting considerably beyond appendages (Figs 95, 103).

Measurements. – Males (n=4) abdomen including appendages 41 (38-42) mm, hind wing 26 (24-26) mm; female (n=1) abdomen including appendages 33 mm, hind wing 25 mm.

Comparative notes. – The structure of the superior appendage of the male is unlike that of any of the Sulawesi species. The structure of the inferior appendage of the male is more or less similar to that in *P. geijskesi* and related species.

Remarks

Etymology. – *Rozendalorum,* after Mr. and Mrs. Frank and Carla Rozendaal, ornithologists with a keen interest in Odonata, and collectors of the present species.

Habitat. – Collected together with *Protosticta simplicinervis* Selys and *Rhinocypha frontalis* Selys in a small shaded stream.

Distribution. – Sangihe Islands; only known from the type locality.

Protosticta simplicinervis Selys

(Figs 47-49, 74-75, 88, 96, 104,108, 113)

Protosticta simplicinervis Selys, 1885: cxlv. Lectotype male (here designated) 'Mirabassa / Celebes', and '*Protosticta simplicinervis* Selys' in Selys hand, and several labels from M.A. Lieftinck, in IRSN [examined]. – Kirby 1890: 133 (catalogued); Davies & Tobin 1984: 107 (catalogued); Van Tol 1987: 154 [record Dumoga Bone]; Tsuda 1991: 8 (catalogued).

Protosticta annulata Fraser, 1926: 492. Holotype male: Celebes, Menado (Mohari) in RMNH [examined]. – Lieftinck 1930: 138 [synonymized with *P. simplicinervis*]; Lieftinck 1971: 73 [type examined; synonymized with *P. simplicinervis*]; Davies & Tobin 1984 (catalogued as synonym of *P. simplicinervis*); Tsuda 1991: 209 (catalogued as synonym of *P. simplicinervis*); Bridges 1994 (catalogued as synonym of *Protosticta simplicinervis*).

Protosticta sp. – Askew et al. 1989: 118 [examined].

Description

Large and robust species with relatively long abdomen, immediately recognizable by the paired protuberance

on the middle lobe of the prothorax, and the characteristic shape of the inferior appendages.
Male. – Head. Labium with labial palps brown, median lobe anteriorly brown, rest of mentum creamish white; labrum bluish white with anterior margin black, dark margin in the middle c. half the height of labrum, strongly tapering towards lateral corners; mandibles with anterior margin bluish white with black markings; anteclypeus bluish white, postclypeus shiny black; remaining part of head black with glossy shine anteriorly and velvet black on dorsal surface; two tufts of long setae behind lateral ocelli directed distad.
Thorax. Pronotum (Figs 74-75) with anterior and median lobes predominantly pale coloured, hind lobe dark brown; anterior lobe medially more or less flat; lateral sides depressed in the middle resulting in anterior and posterior ridge; median lobe medio-anteriorly with paired conical structure; posterior lobe simple with only extreme lateral corners somewhat raised, no horn-like structures. Synthorax (Fig. 88) very dark brownish black with purple shine, light coloured parts creamish or bluish white; antehumeral stripe absent, pale stripe over mesepimeron and metepisternum parallel-sided, approximately four-fifths the width of metepisternum; dark stripe over metapleural suture, fading to brown on metepimeron; rest of metepimeron creamish white. Legs pale. Wings (Fig. 108) reaching to halfway abdominal segment 6; Arculus distal to Ax2; origin of R4+5 just proximal to subnodus; four cells between origin of IR3 and R3; seven cells between Cux and place where CuP meets hind margin of wing.
Abdomen. Segments 1-2 somewhat inflated; segments 8-10 strongly inflated, nearly flat on dorsum; dorsum of segments 1-2 ochraceous, lateral sides creamish white; segments 3-7 brown with paler anterior part gradually increasing from 1/10th on segment 3 to 1/5th on segment 7; dorsum of segments 8-10 with distinct pale blue spot, consisting of an oblong semi-circular marking on posterior 4/5th of segment 8, a complete blue segment 9, and segment 10 blue except for a narrow brownish black ring on segment 10.
Appendages (Figs 47-49) pale ochraceous, superiors in dorsal view directed medio-ventrad, top somewhat club-shaped, but not distinctly wider than base, dorsal side with conspicuous spine halfway; inferiors in ventral view with top glossy pale brown, bent 90° inwards, with its very tip sharply bent dorsad; subterminal tooth directed medio-dorsad.
Female. – As male, including the paired conical protuberance on the median lobe of prothorax; coloration of abdominal segments 1-7 also as in male, segment 8 brown with latero-anterior pale markings, segment 9 (Figs 96, 104) with dorsal line dark, posterior 2/5th of segment dark, but pale towards sternites; latero-anterior part pale; segment 10 brown, darker on dorsum; appendages short, brown; valves brownish black, top of terebra pale coloured, stylus long and slender.
Measurements. – Male (n=10) abdomen including appendages 43 (39-47) mm, hind wing 28 (25-30) mm; female (n=6) abdomen 39 (37-41) mm, hind wing 30 (29-32) mm.

Variation. – No notable geographical variation. The specimen from Sangihe is not markedly different from the Sulawesi specimens.

Comparative notes. – Males and females can easily be distinguished from other Sulawesi species of *Protosticta* by the conical structures (protuberances) on the dorsum of the median lobe of the prothorax. A species group in its own.

Material examined

In total 37 males and 19 females, including lectotype male and paralectotype male 'Mirabassa / Celebes' (in IRSN), and the holotype of *Protosticta annulata* Fraser, and further as follows: Sangihe Islands: NW slope Gn Sahendaruman (SSW Liwung), 3°32'N 125°32'E. 600-650 m, 12-15 May 1985, 1 male 1 female (F.G. Rozendaal) in RMNH [JvT 1973-1974]. – N Sulawesi (Celebes), localities arranged from west to east: Sabang Dampelas; Toli Toli; Leok; Ile Ile 500-800 m; Gorontalo heuvelland Kwandang alt 200 m; Dumoga Bone National Park, several stations 200-600 m; Tondano: pool between Airmadidi and Tondano 600 m; surroundings Ranotongkor; Mapanget; Pineleng, 250 m (various collectors) in RMNH, IRSN, collection D.A.L. Davies. – Central Sulawesi. c. 10 km WNW Palopo near Tojambu (Puncak), 800-1000 m, c 2°56'N 120°07'E, Jul/Aug 1991 (native

collector Yohan), 1 male 5 females; Masamba inland, river and tributaries, c. 2°30'S 120°25'E, 1-2 Nov 1993, 2 males (Yohan R.).

Remarks

Habitat. – Found along densely shaded small streams, as well as along more open larger streams. I am uncertain about the breeding habitat of this species. Most likely the larvae are living in small shaded streams rather than in the large streams. As far as I am aware, all records from larger streams are close to brooklets or creeks.

Distribution. – Central Sulawesi (uncommon), and the dominating *Protosticta* of the northern peninsula (north of Dampelas), also Sangihe Islands (Fig. 113). The species has repeatedly been found by professional collectors around Palopo (Tojambu, Masamba), but I have been unable to find this species here myself. Thus, the precise habitat of this species in that area remains uncertain.

Note. – While males of most *Protosticta* species are dominating in collections, females of *P. simplicinervis* are remarkably common in the material examined.

Protosticta vanderstarrei sp. n.

(Figs 50-53, 76-77, 89, 97, 105, 109, 113)

Type material. – Holotype male: 'Celebes, Polewali, 23 Oct 1940 (J.J. van der Starre)' [JvT 1883] in RMNH. – Paratypes 13 males and 2 female: Same site and same collector as holotype, 23 Oct 1940, 2 males [JvT 1884, 1888], 6 Aug 1940, 1 female [JvT 1887]; Lindoe-vlakte, loc. XVIII [near Lake Lindu], alt. 850 m, 8 Aug 1940, 2 males (one incomplete) [JvT 1885- 1886]; 30 km N of Wotu: Sg Anoa, waterfall near bridge Wotu-Tentena, 650 m, 23 Oct 1993, 1 male (J. van Tol) in RMNH [JvT 1500]; N of Madjene, Onan, Sg. Parabaya, 5 males 1 female (J.P. Duffels) [JvT 6019, 6020, 6028-6031] in ZMAN, 1 male in RMNH; S of Palu, Lore Lindu NP: Kamarora, small brooklets, 700 m, 7-8 Apr 1997, 2 males (J. van Tol) in RMNH, MBBJ [JvT 16636, 16638]; same, first large river crossing trail to Nokilalaki, 9 Apr 1997, 1 male (J. van Tol) [JvT 16655] in RMNH.

Additional material, excluded from type series. – Celebes, Ile Ile, 5-800 m, Dec 1930, 1 male 1 female (S. Heinrich) [identified as *Protosticta* sp. – by Lieftinck] in RMNH [JvT 1889, 1890]; 65 km SSE of Palu: Lore Lindu NP near Marena shelter, 600 m, 17 Dec 1985, 2 males (J. van Tol) in RMNH, MBBJ [JvT 1874-1875]. I have also seen a male from Northern Sulawesi, Dumoga Bone National Park, 1985, in coll. D.A.L. Davies, Cambridge.

Description

Small species with very dark synthorax, especially so since it lacks pale coloration on metepimeron; general appearance as *Drepanosticta* rather than *Protosticta*.

Male [holotype, JvT 1883]. – Head. Labium concolorous ochraceous; labrum bluish white with narrow brown-black anterior border, wider in middle than lateral corners; mandibles shining bluish white; anteclypeus bluish white, postclypeus and remaining part of head black; antennae with scapus brown, pedicellus pale ochraceous, flagellum pale brown.

Thorax. Pronotum (Figs 76-77) with anterior and posterior lobe brownish black; anterior lobe erect, but not turned posteriad; median lobe pale yellow without significant characters (specimens from the Lindu valley have a brown median lobe); posterior lobe flat, hind margin hardly indented. Synthorax (Fig. 89) very dark chestnut brown, dorsally nearly black, with only one lateral pale yellowish stripe above metastigma parallel to second lateral suture, stripe pointed anteriorly, wider dorsal part stops aslant before posterior margin of synthorax; metepimeron and metakatepisternum dark without pale marking. Legs greyish yellow, joints of femora and tibiae greyish brown, also a grey ring at one-third from joint of femur. Wing length 21 mm; pterostigma subquadrate with oblique inner corner; Arculus just distal to Ax2 (Fig. 109); origin of R4+5 in fore and hind wing approximately at subnodus; six cells between origin of IR3 and R3; nine cells between Ac (Cux) and place where CuP meets hind margin.

Abdomen. Length including anal appendages 32 mm. Segments 1 and 2 somewhat inflated, segments 8-10 relatively little wider than preceding segments; segment 1 ochraceous with lateral crescent-shaped brown marking connected with hind margin; segment 2 castaneous with a small latero-anterior spot; segment 3-6 brown, anteriorly c. one-fifth to oneeighth ochraceous, but dorsally with narrow brown stripe, segments 7-8 brownish black, segment 7 somewhat paler anteriorly; segment 8 without any trace of

pale coloration; segments 9-10 blue, ventro-laterally bordered with black, hind margin of segment 10 black; ventral side of abdominal segments 8-9 blue; anal appendages (Figs 50-53) relatively short, superiors laterally inflated, top rectangular, dorsal tubercle stout; inferiors club-shaped, tapering towards the top, ending in short S-curve, subterminal innertooth very slim and slender, nearly filamentous.
Female. – As the male, in coloration; abdomen shorter and less slender than that of male, segments 3- 7 brown, but anterior one-sixth to one-fifth creamish yellow, segment 8 brown with latero-anterior twinspot, segment 9 (Figs 97, 105) pale blue with a brown dorsal stripe, somewhat widening posteriorly, ventral side of tergite also brown, segment 10 and appendages brownish black; valves castaneous, projecting just beyond appendages, stylus long and slender.
Measurements. – Male abdomen including appendages 32-34 mm; hind wing 21-22 mm; female abdomen 23 mm, hind wing 21 mm.

Variation. – Not much variation in structural details, apart from the pterostigma, which is subquadrate to rhomboidal, with distal side straight to rather convex. Middle lobe of pronotum sometimes without dark markings, but in some specimens with rather extensive dark brown spot, fading towards edges ('burnt'). Significant variation in coloration of last abdominal segments. Specimens with extensive blue markings (as in JvT 16636 from Kamarora) have a lateral blue line along lateral margin of tergites 8, dorsum of segment 9 fully blue, and dorsum of segment 10 blue except from narrow black line along hind margin; sternites of segment 8 and 9 blue; innerside of superior appendages pale coloured. Another specimen from Kamarora (JvT 16655) with only small pale dorsal markings on abdomen: segment 9 with subtriangular paired white spot in anterior half, a small twinspot dorsally near hind margin, segment 10 with only a small rounded twinspot near anterior margin; sternites blue as in JvT 16636. A specimen from Wotu (JvT 1500) with very extensive markings, viz. with a small blue twinspot in anterior half of segment 8. Specimens collected near Gimpu (Lore Lindu NP) (JvT 1874, 1875) completely lack pale dorsal abdominal markings, but have blue coloured sternites as described above. Most older material too much discoloured to examine pale coloration.

Comparative notes. – Not similar to any of the other Sulawesi platystictids here assigned to *Protosticta*. As indicated elsewhere, the correct generic assignment of this species has to await a generic revision of the Platystictidae. The general appearance is more similar to *Drepanosticta*, but its structural details studied so far are too generalized to postulate another generic position than *Protosticta*.

Remarks
Etymology. – *Vanderstarrei*, after Mr. J.J. van der Starre, who travelled extensively along the coasts of Sulawesi in the early 1940's, collecting many interesting Odonata in areas previously unexplored and even poorly investigated today. Mr. Van der Starre also collected the holotype of this species.
Habitat. – One of the labels gives 'overhangende takken boschbeek' (overhanging branches forest stream); presumably not in lowland areas. My own observations indicate that *P. vanderstarrei* occurs only in low densities at strongly shaded sites in dense forest. Larvae possibly live in seepage areas or trickles, a habitat encountered on all sites where this species was collected. Most sites between 500 and 850 m.
Distribution. – Widespread in Central Sulawesi, apparently very local in the northern peninsula.

Unplaced specimens

I have been unable to attribute three specimens to any of the species described in this paper. They are incomplete or damaged, but almost certainly they represent three different, undescribed species.
Mamasa, along brooklet, 1550 m, 11 Apr 1991, 1 male (J. van Tol) in RMNH [JvT 19353]. Teneral specimen, with anal appendages rather damaged. The structure of the anal appendages reminds of *Protosticta maurenbrecheri*, but the synthorax lacks the antehumeral stripe.

Ile Ile, 500-800m, Anf. 12.30 [= early December 1930], 1 male (G. Heinrich) in RMNH. Specimen misses last abdominal segments. The anterior lobe of the prothorax has some resemblance to *P. marenae*, but it is sufficiently different to suppose that it represents an undescribed species.
Sulawesi Utara, Dumoga Bone Nat. Park, river Tumpah (200 m), X-1985. Station 045 (R. Bosmans & J. Van Stalle, 1 female (in IRSN) [JvT 16880]. This specimen is different from any other female of *Protosticta* I have seen, based on the coloration of the last abdominal segments and the structure of the prothorax. Unfortunately, it is also too much damaged to be described as a new species.

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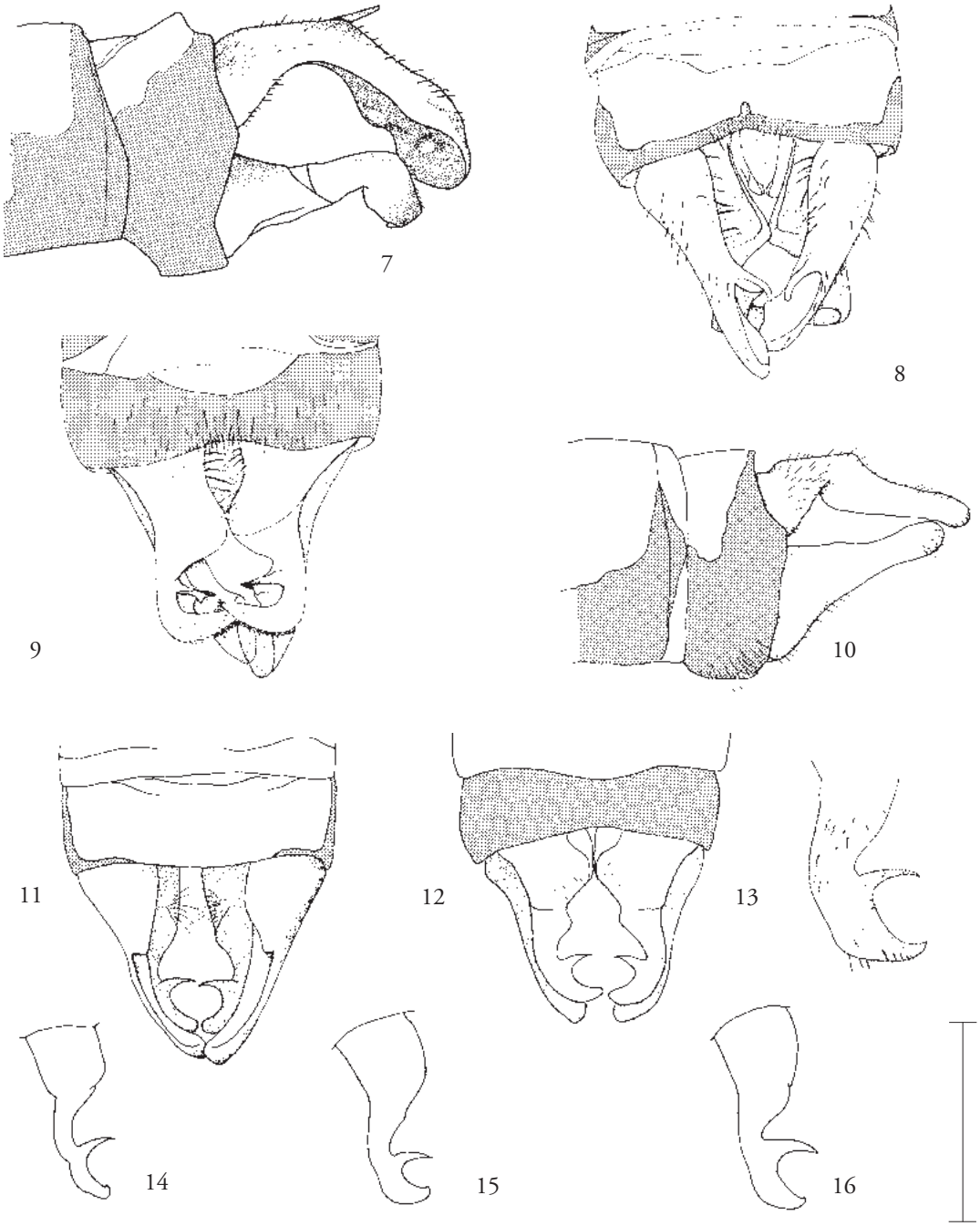
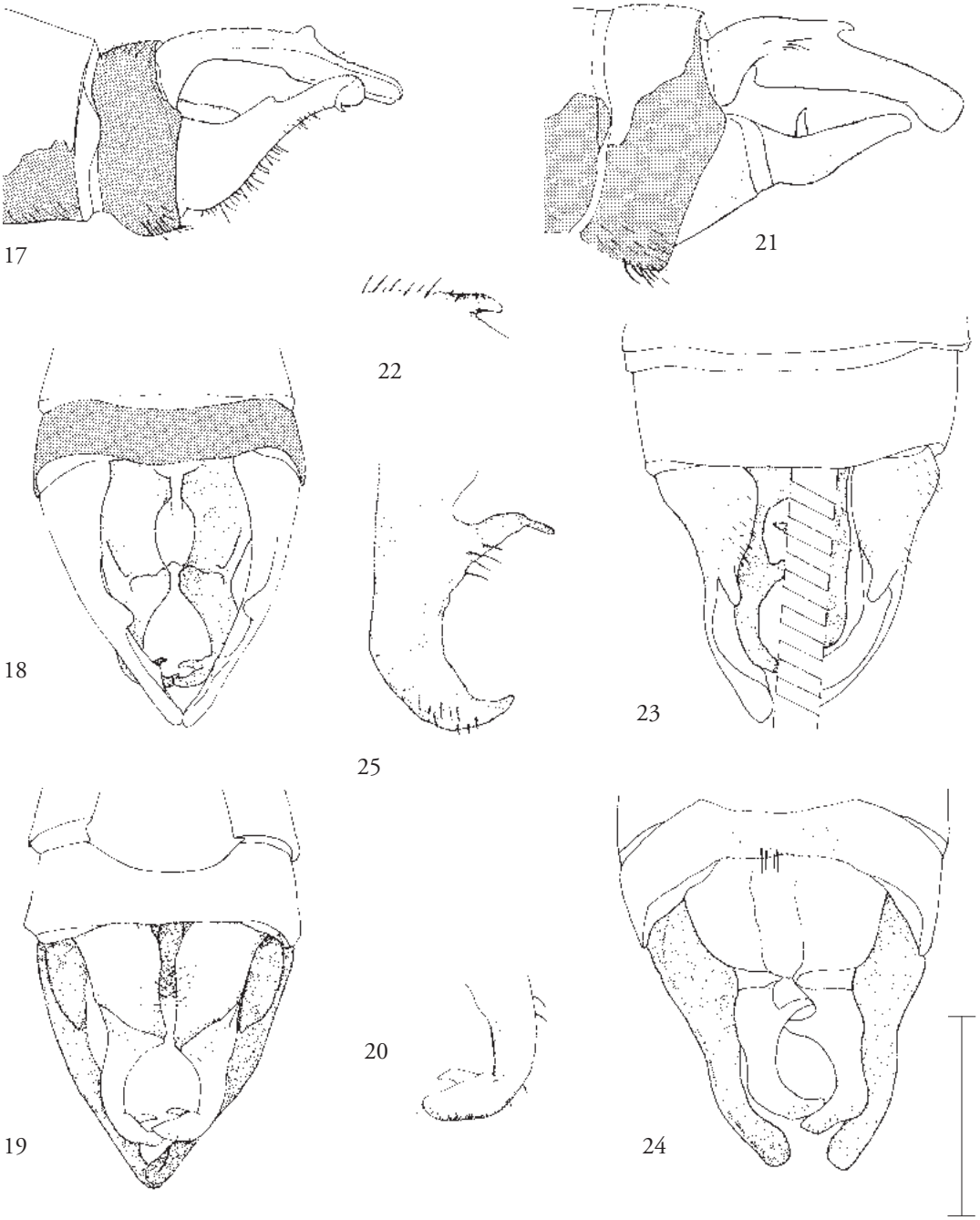
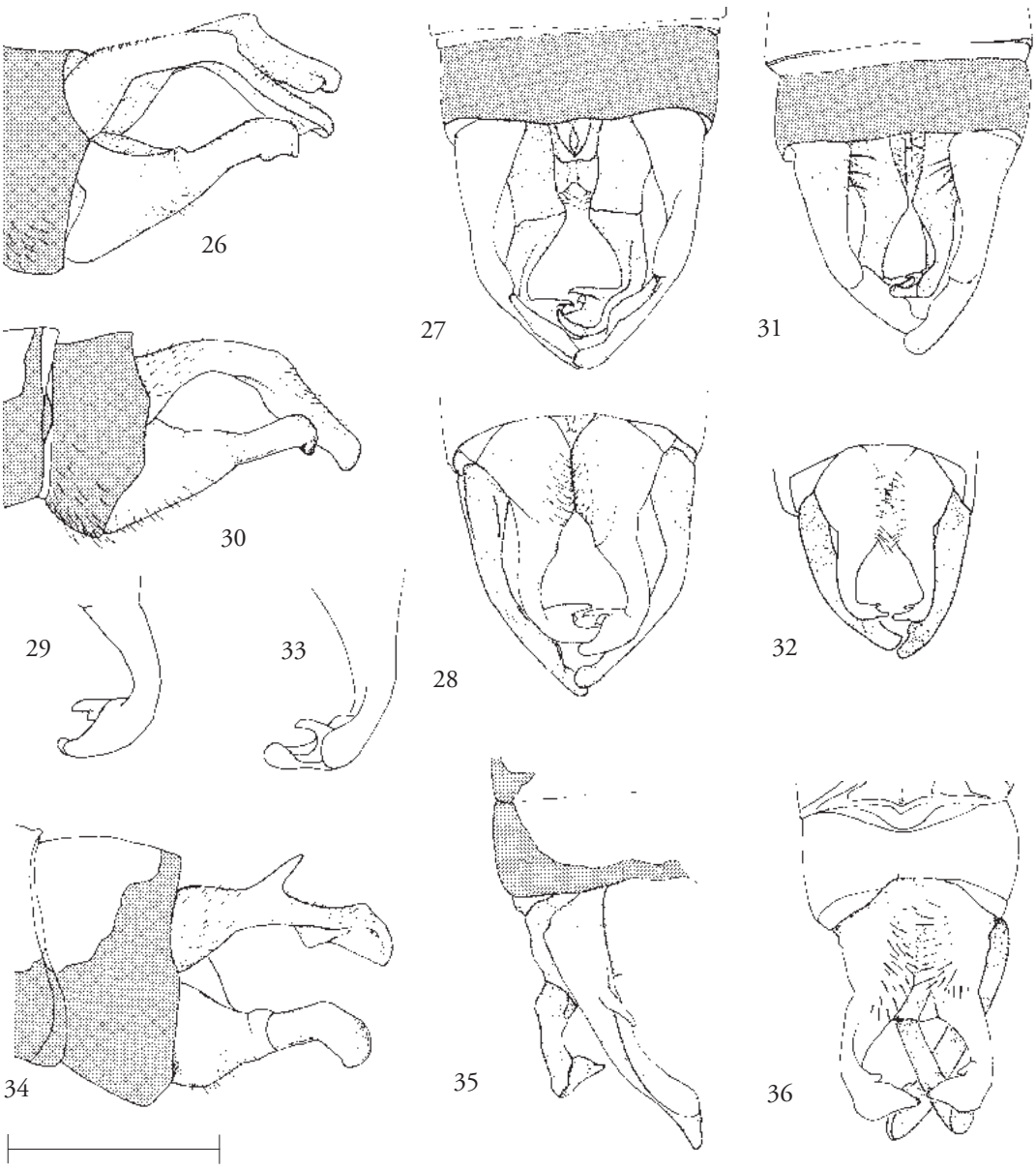


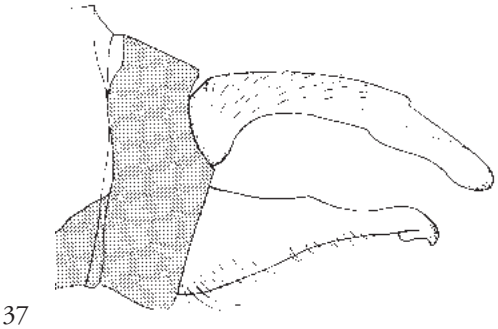
Figures 7-16. Last abdominal segments and anal appendages of male. – 7-9, *Protosticta bivittata* Lieftinck. 7, left lateral; 8, dorsal; 9, ventral view (JvT 1842, SW Sulawesi, Bantimurung area, 31 May 1982). – 10-16, *Protosticta coomansi* sp. n., 10, left lateral; 11, dorsal; 12, ventral view (JvT 16606, C. Sulawesi, N of Gimpu, 4 Apr 1997), 13, same, inferior appendage, high magnification (JvT 16661, SW Sulawesi, Loewoe, Todjamboe, 18 Jul 1936), 14, same, inferior appendage ventral view (JvT 2033, SW Sulawesi, Maros area); 15, same (JvT 16582, C Sulawesi, Gimpu); 16, same (JvT 2009, C. Sulawesi, Leok). Scale bar 1 mm (for all figures, except for fig. 13 = 0.5 mm).



Figures 17-25. Last abdominal segments and anal appendages of male *Protosticta*. – 17-20, *P. geijskesi* sp. n. 17, left lateral; 18, dorsal; 19, ventral view; 20, appendix inferior in ventral view at higher magnification (JvT 1891, NW Sulawesi, Sabang, Dampelas, 30 Jan 1941. – 21-25. *Protosticta gracilis* Kirby. 21, left lateral; 22, dorsal tooth of superior appendage in lateral view; 23, dorsal view (piercing straw indicated); 24, ventral view; 25, appendix inferior in ventral view (all holotype, NE Sulawesi, Manado, Tondano). Scale bar 1 mm (for figures 17-19, 21, 23-24), 0.5 mm (for figures 20, 22, 25).



Figures 26-33. Last abdominal segments and anal appendages of male *Protosticta*. – 26-29, *P. linduensis* sp. n., left lateral, dorsal and ventral view, and appendix inferior in ventral view at higher magnification (JvT 1857/8, SW Sulawesi, Polewali, 23 Oct 1940). – 30-33, *P. marenae* sp. n., left lateral, dorsal and ventral view, and appendix inferior in dorsal view at higher magnification (various specimens from C. Sulawesi, Gimpu area). – 34-36. Last abdominal segments and anal appendages of male *Protosticta*. – 34-36, *P. maurenbrecheri* sp. n., left lateral, dorsal and ventral view (JvT 1870, 1873, C. Sulawesi, Loewoe, Masamba, S. Baebunta, Apr and May 1940)
Scale bar 1 mm (for figures 26-28, 30-32, 34-36), 0.5 mm (for figures 29, 33).



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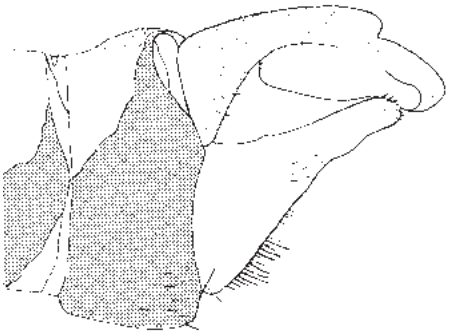

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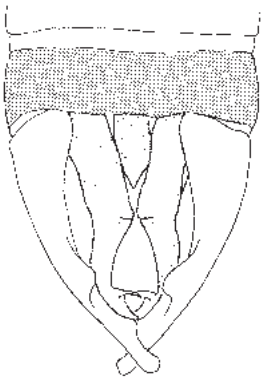

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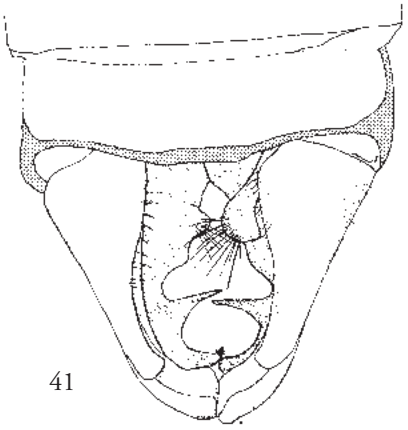

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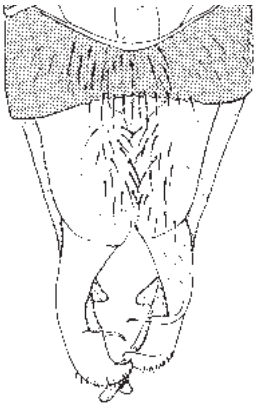

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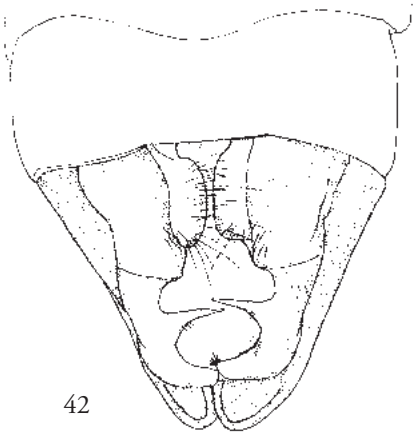

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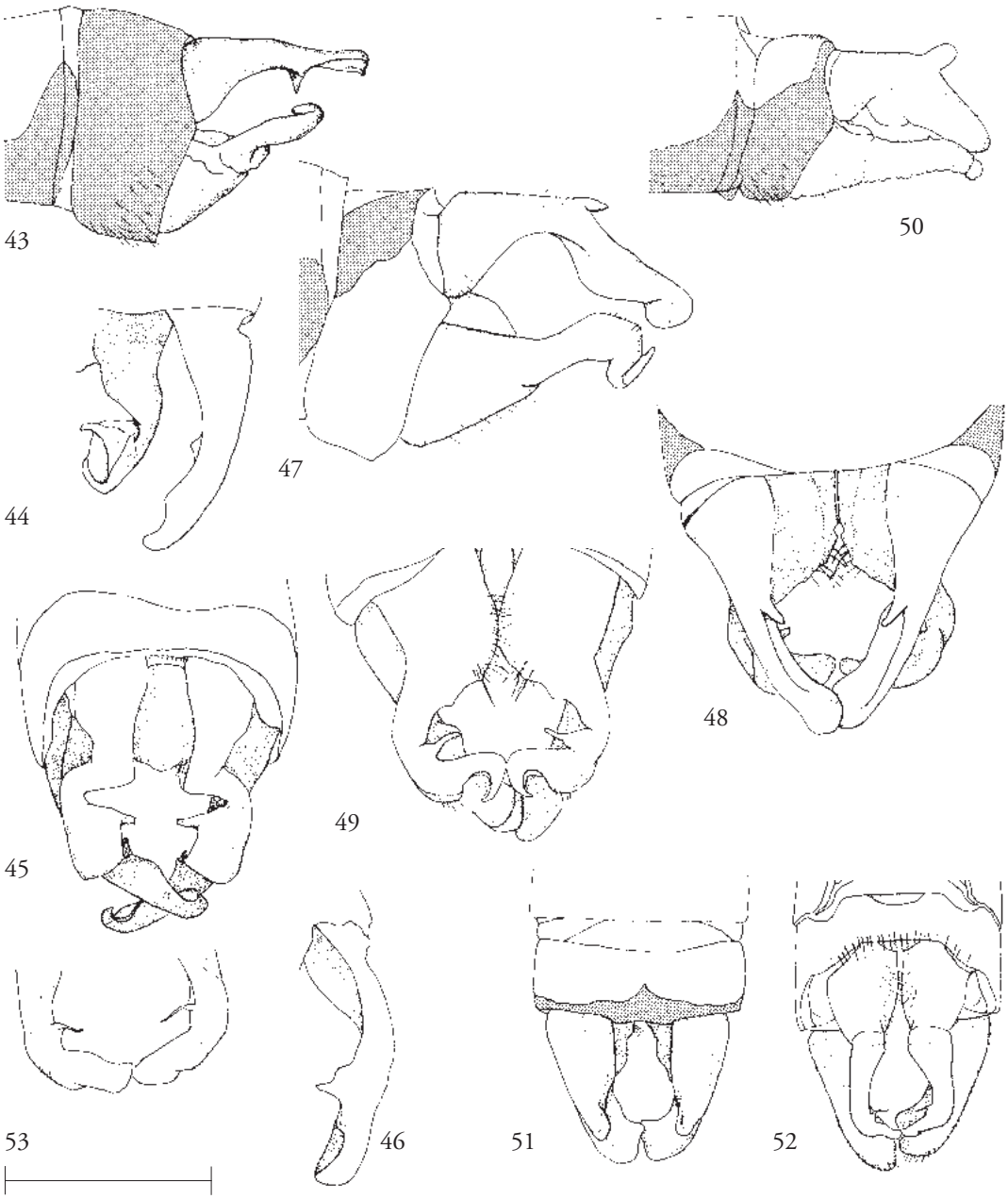
Figures 37-42. Last abdominal segments and anal appendages of male *Protosticta*. – 37-39, *P. pariwonoi* sp. n., left lateral, dorsal and ventral view (JvT 5232, 5254, SW Sualwesi, Bantimurung area). – 40-42, *P. reslae* sp. n., left lateral, dorsal and ventral view (JvT 1876, SW Sulawesi, Polewali, 6 Aug 1940). Scale bar 1 mm.



Figures 43-53. Last abdominal segments and anal appendages of male *Protosticta*. – 43-46, *P. rozendalorum* sp. n., left lateral, dorsal and ventral view, and (46) innerside of right superior appendages (JvT 1878, N. of Sulawesi, Sangihe Is., Manganitu, 1985). – 47-49, *P. simplicinervis* Selys, left lateral, dorsal and ventral view (JvT 1947, NE Sulawesi, Mapanget, 28 Jul 1940). – 50-53, *P. vanderstarrei* sp. n., left lateral, dorsal and ventral view (JvT 1888, SW Sulawesi, Polewali, 23 Oct 1940).
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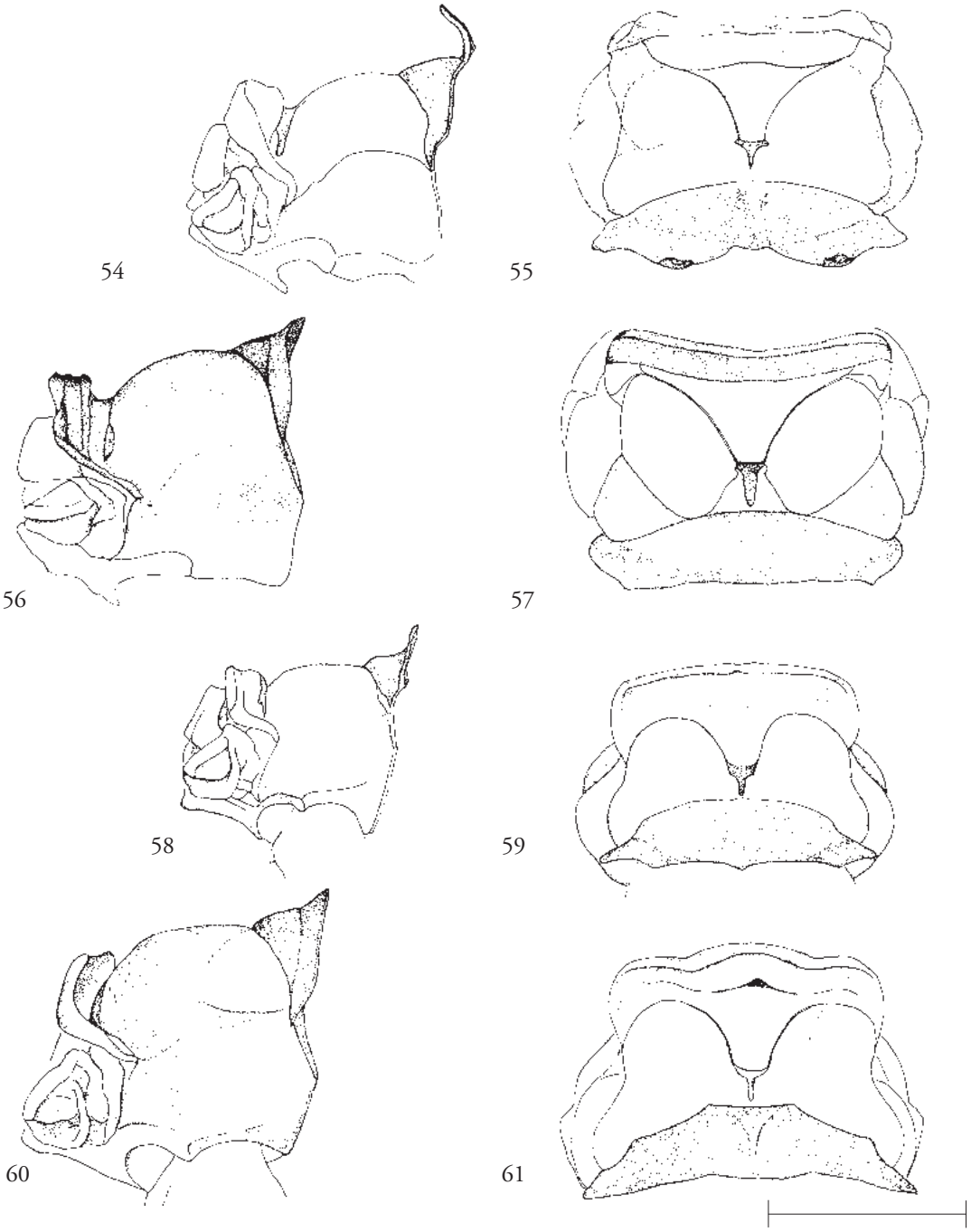
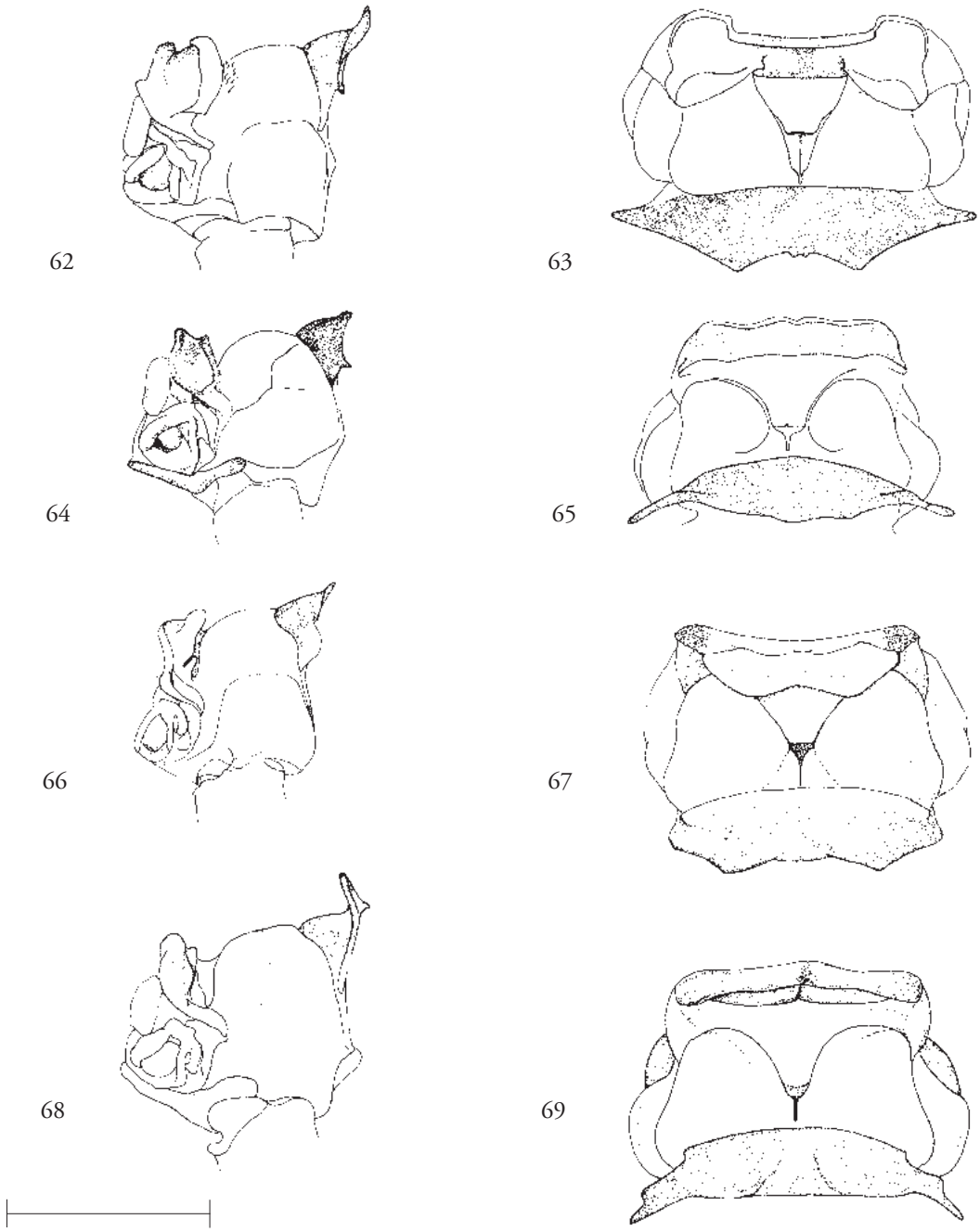
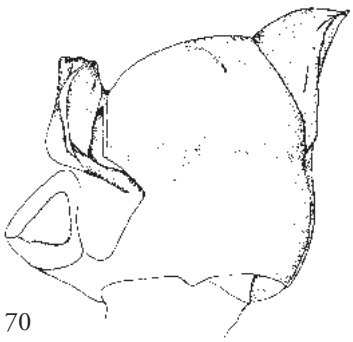


Figures 54-61. Pronotum of *Protosticta* species in left lateral and dorsal view. – 54-55, *P. bivittata* Lieftinck (JvT 1842, SW Sulawesi, Bantimurung area, 31 May 1982). – 56-57, *P. coomansi* sp. n. (JvT 16853, C. Sulawesi, N. of Gimpu, 16 Dec 1985). – 58-59, *P. geijskesi* sp. n. (JvT 1891, C. Sulawesi, Sabang, Dampelas, 30 Jan 1941). – 60-61, *P. gracilis* Kirby (holotype). Scale bar 1 mm.



Figures 62-69. Pronotum of *Protosticta* in left lateral and dorsal view. – 62-63, *P. linduensis* sp. n. (JvT 1861, C Sulawesi, Lore Lindu NP, 9 Dec 1985). – 64-65, *P. marenae* (JvT 1866, C Sulawesi, Lore Lindu NP, 16 Dec 1985). – 66-67, *P. maurenbrecheri* sp. n. (JvT 1873, C Sulawesi, S. Baebunta, 17 Apr 1940). – 68-69, *P. pariwonoi* sp. n. (JvT 5230, SW Sulawesi, Bantimurung area, 24 Sep 1983). Scale bar 1 mm.



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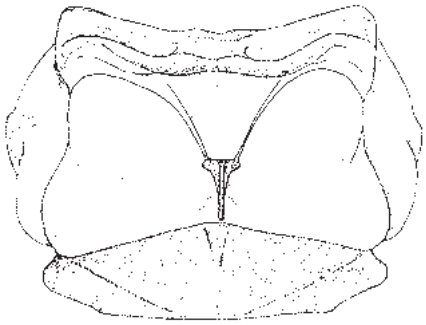

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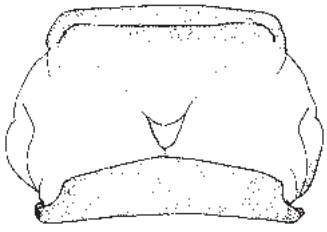

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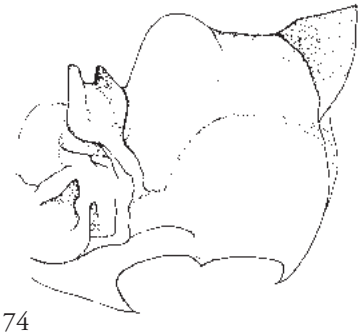

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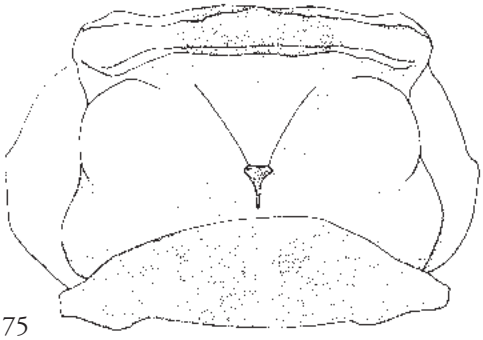

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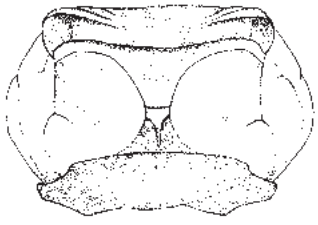

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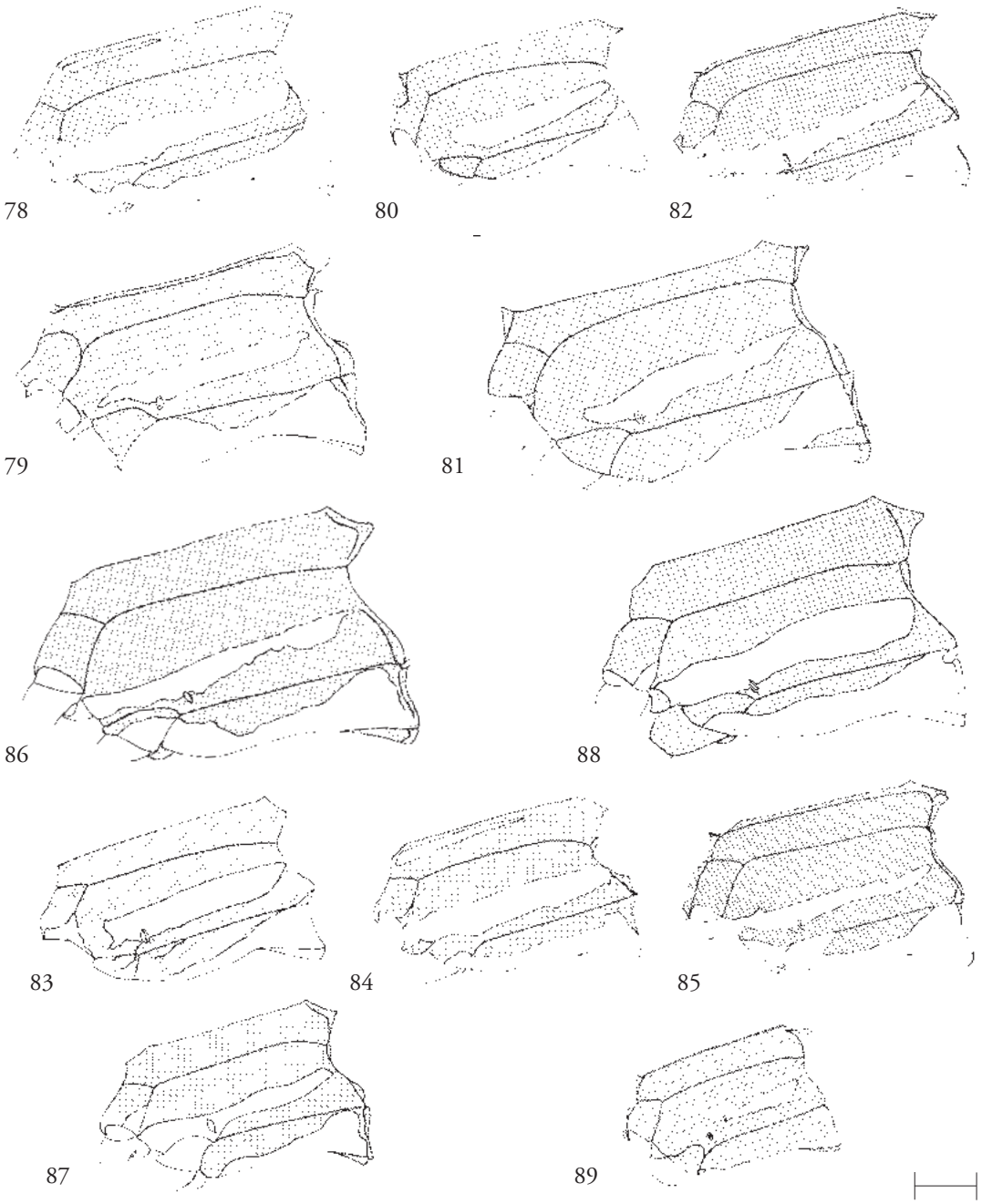
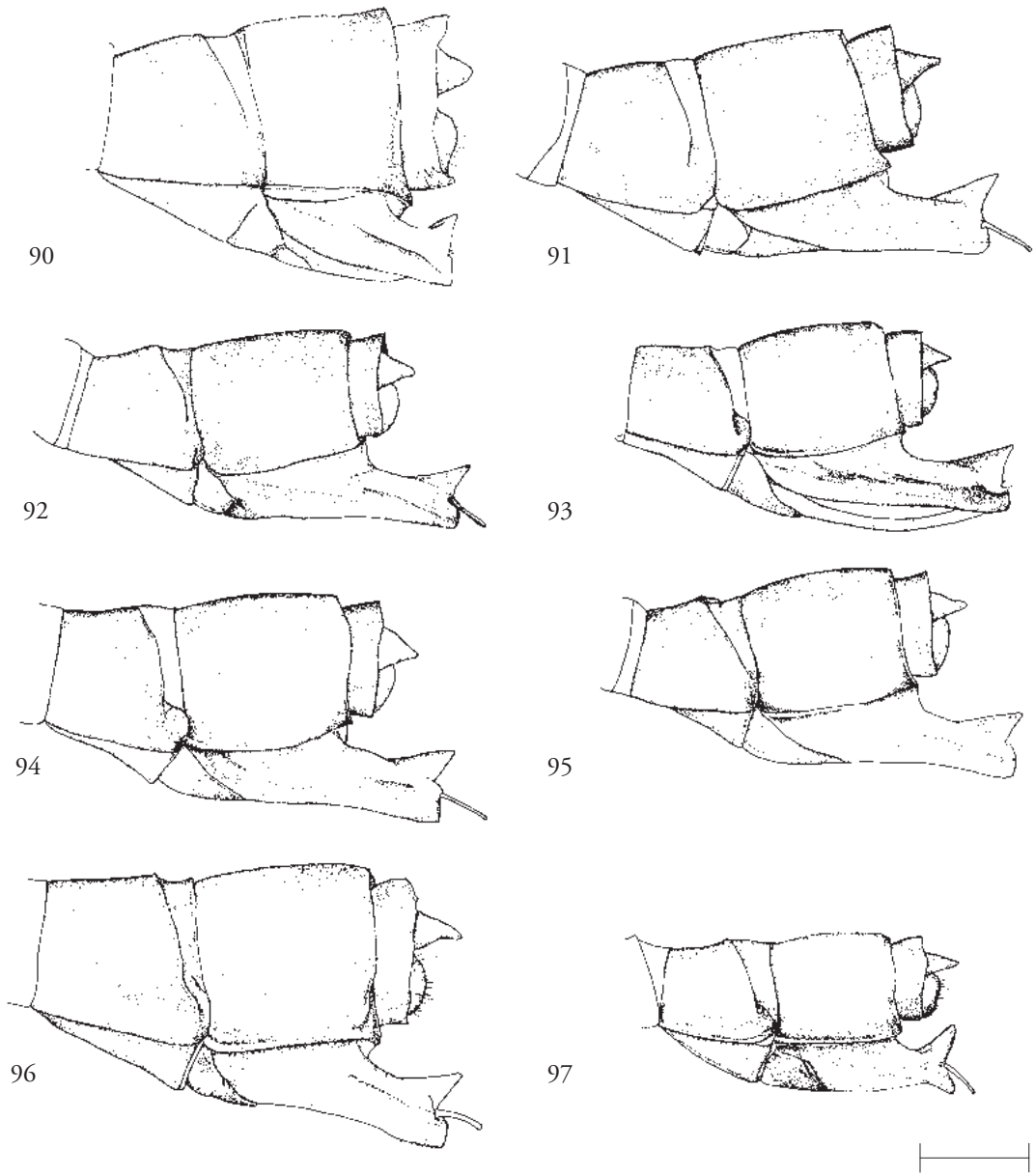
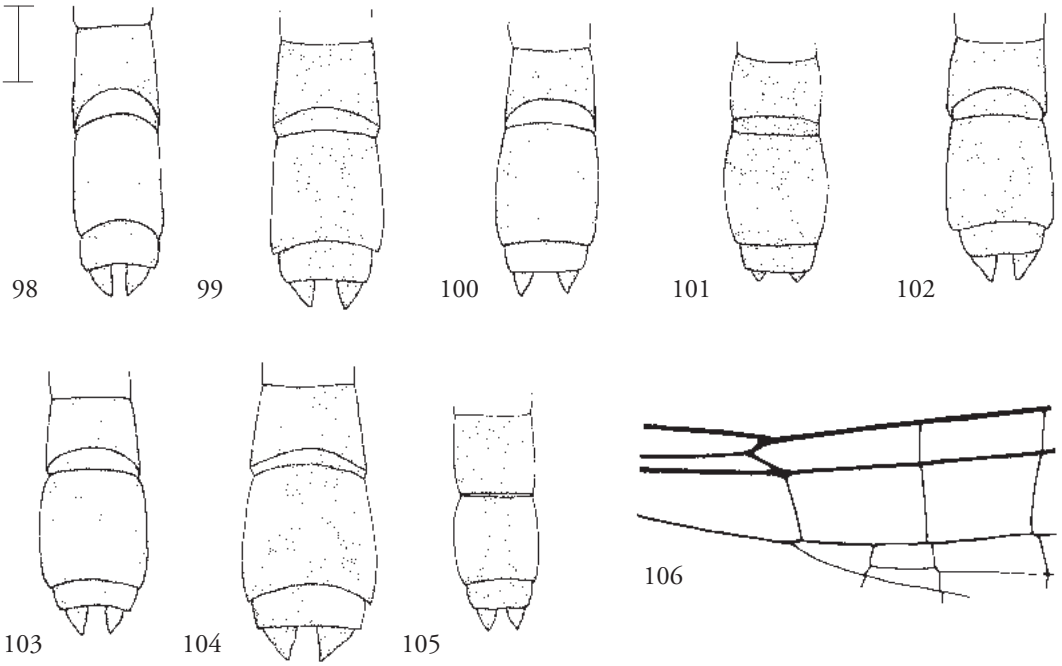
Figures 70-77. Pronotum of *Protosticta* in left lateral and dorsal view. – 70-71, *P. reslae* sp. n. (JvT 1876, SW Sulawesi, Polewali, 6 Aug 1940). – 72-73, *P. rozendalorum* sp. n. (JvT 1878, Sangihe Is). – 74-75, *P. simplicinervis* Selys (JvT 1947, NE Sulawesi, Mapanget, 28 Jul 1940). – 76-77, *P. vanderstarrei* sp. n. (JvT 1885, C Sulawesi, Paloe, Lindu valley, 8 Aug 1940).
Scale bar 1 mm.

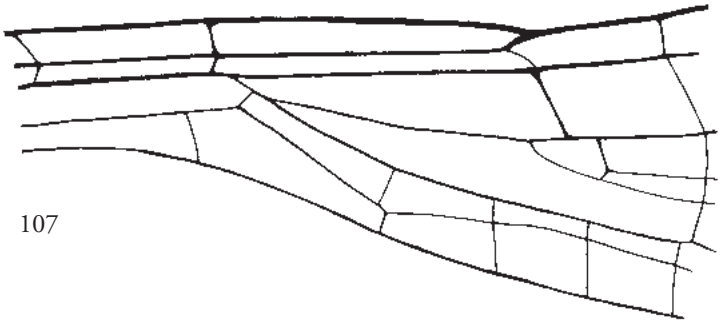


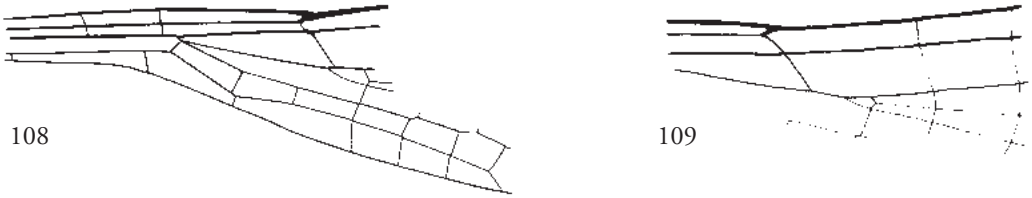
Figures 78-83. Synthorax of *Protosticta* in lateral view. – 78, *P. bivittata* Lieftinck (JvT 1842, SW Sulawesi, Bantimurung area, 31 May 1982). – 79, *P. coomansi* sp. n. (JvT 16661, SW Sulawesi, Loewoe, Todjamboe, 18 Jul 1936). – 80, *P. geijskesi* sp. n. (JvT1917, C Sulawesi, S. Baebunta, 25 Aug 1940). – 81, *P. gracilis* Kirby (holotype); 82, *P. linduensis* sp. n. (JvT 1861, C Sulawesi, Lore Lindu NP, 9 Dec 1985). – 83, *P. marenae* sp. n. (JvT 1862, C Sulawesi, Gimpu area, 14 Dec 1985). – 84, *P. maurenbrecheri* sp. n. (JvT 1873, C Sulawesi, S Baebunta, 17 Apr 1940). – 85, *P. pariwonoi* sp. n. (JvT 5230, SW Sulawesi, Bantimurung area, 24 Sep 1983). – 86, *P. reslae* sp. n. (JvT 1876, SW Sulawesi, Polewali, 6 Aug 1940). – 87, *P. rozendalorum* sp. n. (JvT 1878, Sangihe Is, Manganitu, May 1985). – 88, *P. simplicinervis* Selys (JvT 1943, N Sulawesi, Dumoga Bone NP, 20 May 1985). – 89, *P. vanderstarrei* sp. n. (JvT 1888, SW Sulawesi, Polewali, 23 Oct 1940). Scale bar 1 mm.



Figures 90-97. Last abdominal segments of female, left lateral view. – 90, *P. bivittata* Lieftinck (JvT 1841, SW Sulawesi, Bantimurung area, 31 May 1982). – 91, *P. coomansi* sp. n. (JvT 16617, C Sulawesi, Gimpu, 4 Apr 1997); 92, *P. geijskesi* sp. n. (JvT11886, SE Sulawesi, Mokowu, 29 Oct 1989). – 93, *P. marenae* sp. n. (JvT 16580, C Sulawesi, Gimpu area, 2 Apr 1997). — 94, *P. pariwonoi* sp. n. (JvT 5257, SW Sulawesi, Bantimurung area, 17 Apr 1991). – 95, *P. rozendalorum* sp. n. (JvT 1882, Sangihe Is., Gn Sahendaruman, 12-19 May 1985). – 96, *P. simplicinervis* Selys (JvT 1942, N Sulawesi, Dumoga Bone NP, 30 Apr 1985). – 97, *P. vanderstarrei* sp. n. (JvT 1887, SW Sulawesi, Polewali, 6 Aug 1940). Scale bar 1 mm.

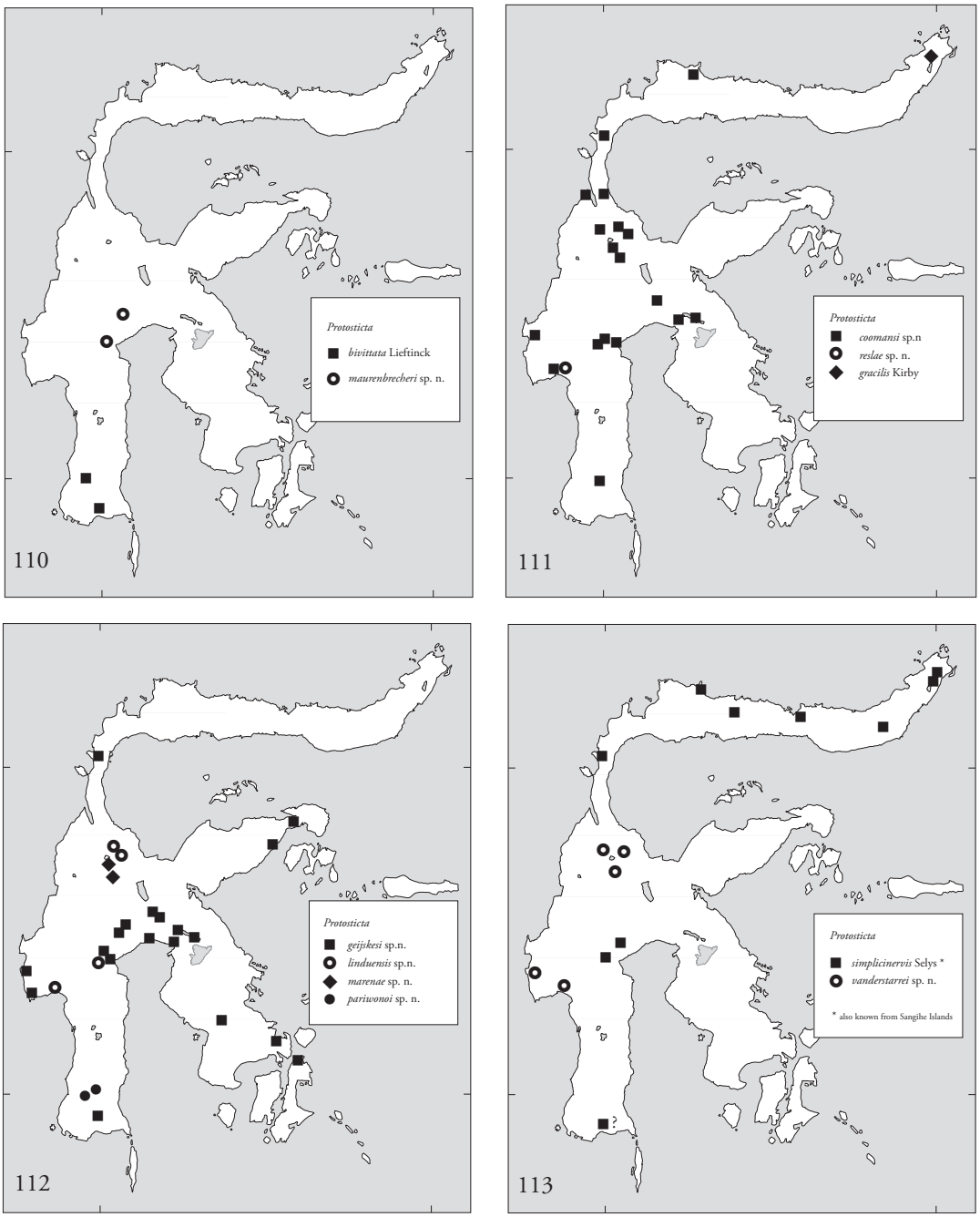






Figures 98-105. Last abdominal segments of female, dorsal view. All data as in figs. 90-97. – 98, *P. bivittata* Lieftinck. — 99, *P. coomansi* sp. n. – 100, *P. geijskesi* sp. n. – 101, *P. marenae* sp. n. – 102, *P. parinonoi* sp.n. – 103, *P. rozendalorum* sp. n. –104, *P. simplicinervis* Selys. – 105, *P. vanderstarrei* sp. n. Scale bar 1 mm.

Figures 106-109. Wing characters of *Protosticta* species. – 106, *P. bivittata* Lieftinck. – 107, *P. gracilis* Kirby. – 108, *P. simplicinervis* Selys. – 109, *P. vanderstarrei* sp. n. (JvT 1888, SW Sulawesi, Polewali, 23 Oct 1940). Various magnifications.



Figures 110-113. Distribution of *Protosticta* species in Sulawesi.