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CUTICULAR BLADES AND OTHER STRUCTURES OF *DIAPREPOCORIS* KIRKALDY AND *STENOCORIXA* HORVATH (HETEROPTERA: CORIXIDAE)

Lansbury, I., 1991. Cuticular blades and other structures of *Diaprepocoris* Kirkaldy and *Stenocorixa* Horvath (Heteroptera: Corixidae). – Tijdschrift voor Entomologie 134: 35-46, figs. 1-27. [ISSN 0040-7496]. Published 1 July 1991.
Diaprepocoris Kirkaldy and *Stenocorixa* Horvath possess cuticular blades and modified swimming hairs on their hind tibiae and tarsi which resemble those of gyrinids (Coleoptera: Gyrinidae). These have not previously been recorded in the Corixidae. Unusual macrotrichia are also present on the clavus and corium of all known species of both genera. The unique characters of these two genera support their separate subfamily placements.
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A study of the Australasian *Diaprepocoris* has revealed the presence of cuticular blades and modified swimming hairs on the hind tibiae and tarsi. These structures have not previously been reported in the Corixidae. A survey of the corixid genera has shown that a similar combination of cuticular blades and modified swimming hairs are also present in the genus *Stenocorixa* which is restricted to tropical Africa. The cuticular blades and associated specialised swimming hairs are described and their probable function discussed in relation to the nektonic (submerged) swimming strategies and respiration in both subfamilies.

The double hair pile layer on the forewings of *Diaprepocoris* is figured and a dual function suggested for the hair pile. *Diaprepocoris* is compared with *Stenocorixa*, the later apparently having smooth forewings. The relationship between the gas stores of *Diaprepocoris* and the specialised swimming hairs of the hind legs are discussed. No data are at present available for *Stenocorixa*. The taxonomic position (isolation) of the two subfamilies is briefly discussed.

Diaprepocorinae Lundblad, 1928

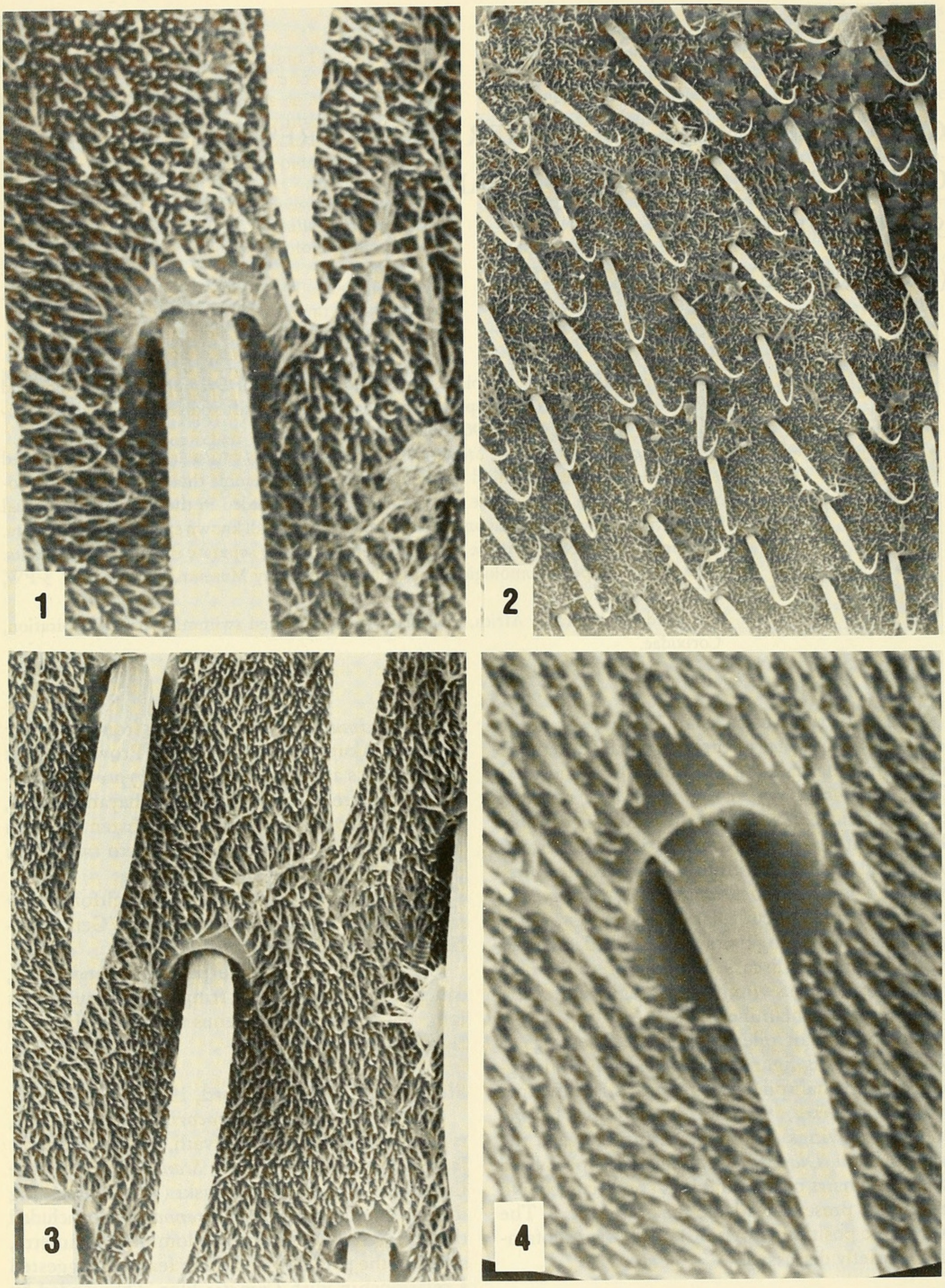
Single extant genus *Diaprepocoris* Kirkaldy, 1897, type species *D. barycephala* Kirkaldy, 1897. Within the *Diaprepocorinae*, Popov (1971) includes *Gazimuria scutellata* Popov, from the lower Jurassic, Akutaev Series, Chitin Province, East Transbaikals and *Karataviella brachyptera* Becker-Migdisova from upper Jurassic, Chayan Region, Chimkent Province, South Kazakhstan. Walton (1940) split the *Diaprepocorinae* into two tribes using the structure of the female pala:

Diaprepocorini. – Female pala digitform, few sieve hairs (about 10) and short. Type/Genus species *Diaprepocoris barycephala*.

Corixanectini. – Female pala short and broad, inner side flattened and fringed with numerous long sieve hairs. Type/Genus species *Corixanecta zealandiae* Hale.

Stenocorixinae Hungerford, 1948

Single extant genus, *Stenocorixa* Horvath, 1927, type species *S. protrusa* Horvath, 1927, monobasic. Jaczewski (1928) placed *Stenocorixa* in the *Corixinae*; Poisson & Jaczewski (1928) discussing the systematic position of *Stenocorixa* concluded that the poorly developed abdominal asymmetry, shape of the pala claw and other features suggested a relationship with *Cymatia* Flor. They ended by stating 'The generic distinctness of *Stenocorixa* Horv. is beyond any doubt and even as a separate genus it seems to stand rather apart of the other genera of the subfamily *Corixinae*'.



Figs. 1-4. *Diaprepocoris barycephala* Kirkaldy. – 1, corium, double hair pile, note collapsed microtrichia and longitudinal ridges on macrotrichia ×3200; 2, inner lateral margin of clavus, note 'shephards crook' macrotrichia ×400; 3, middle of corium ×800; 4, membrane of elytra, note more erect microtrichia and enlarged socket of macrotrichia ×6400. Reduction 84%.

DESCRIPTIVE PART

Diaprepocoris, structure trichia

Macrotrichia of the clavus and corium varying in shape. The hairs along the inner margin of the corium are apically curled over forming a 'shepherds crook' (fig. 2) and are longer and thinner than those on the inner areas adjacent to the clavus (fig. 3). The microtrichia are densely packed and resemble a plastron-like layer however, as they have collapsed and become matted, they clearly do not function as a plastron. The distribution of the microtrichia is fairly uniform over the clavus and corium. The membrane differs in that the microtrichia do not seem to have collapsed as much as those on the clavus and corium (fig. 1 clavus; fig. 4 membrane). The shape of the sockets within the microtrichia from which the macrotrichia arise, structurally suggests that the latter can be elevated and depressed (fig. 1). The macrotrichia are rather more slender and fewer in number on the membrane. Those on the elytra are longitudinally ridged (fig. 1). The division between the double hair layer and the edge of the forewing is distinct (fig. 5). The lateral margin at the nodal furrow shows a scale-like appearance with no hair layers (fig. 6).

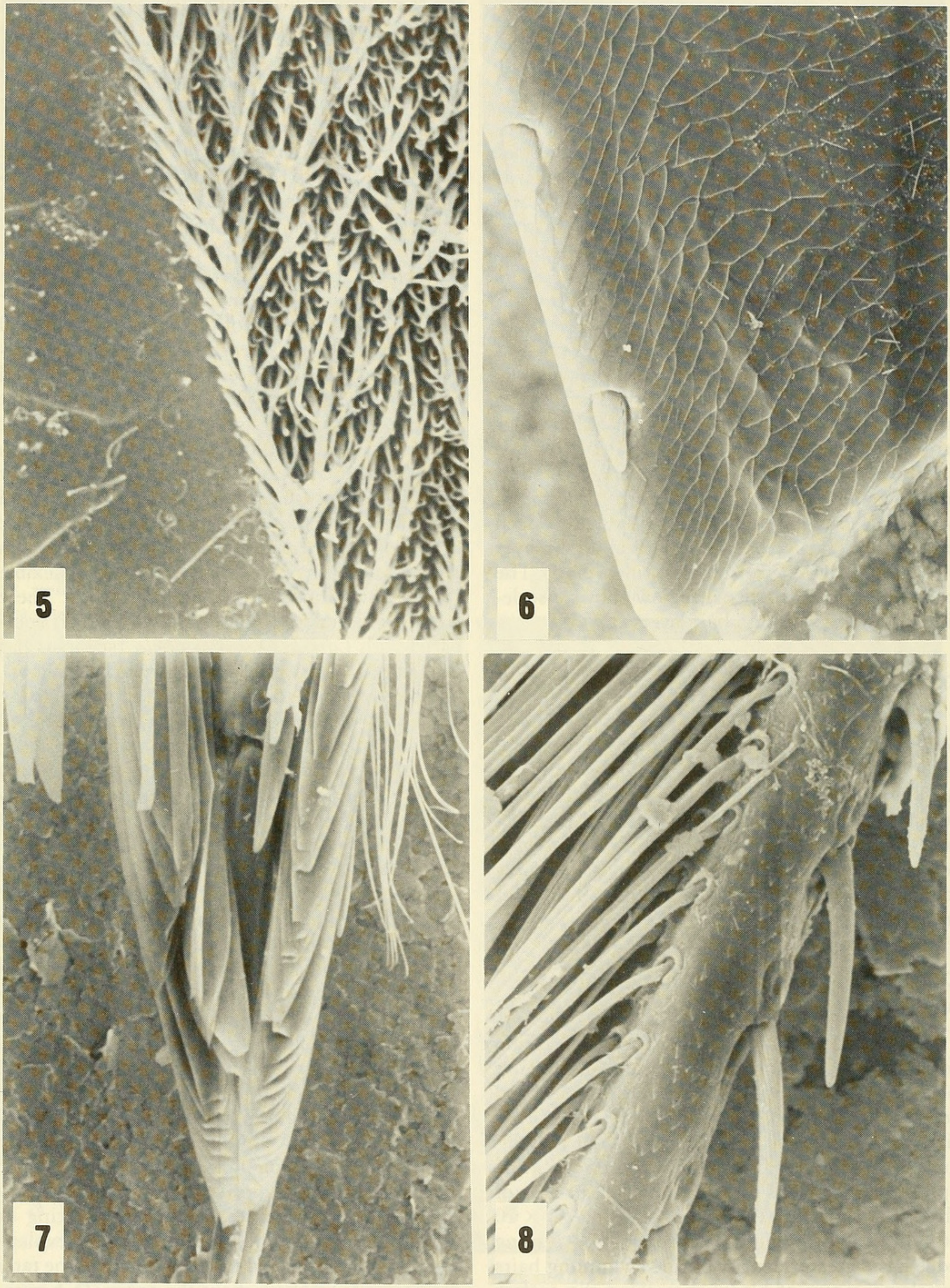
Stenocorixa, structure trichia

Unlike nearly all other genera of corixids, the pronotum and hemelytra are not rastrate, but smooth and shining with scattered long strap-like hairs arising from angled depressions, each with a complete basal ring (fig. 13). Caudad of each depression, an elongate channel within the clavus-corium, the strap-like hairs are almost certainly lodged in the channel(s) when the corixed is swimming.

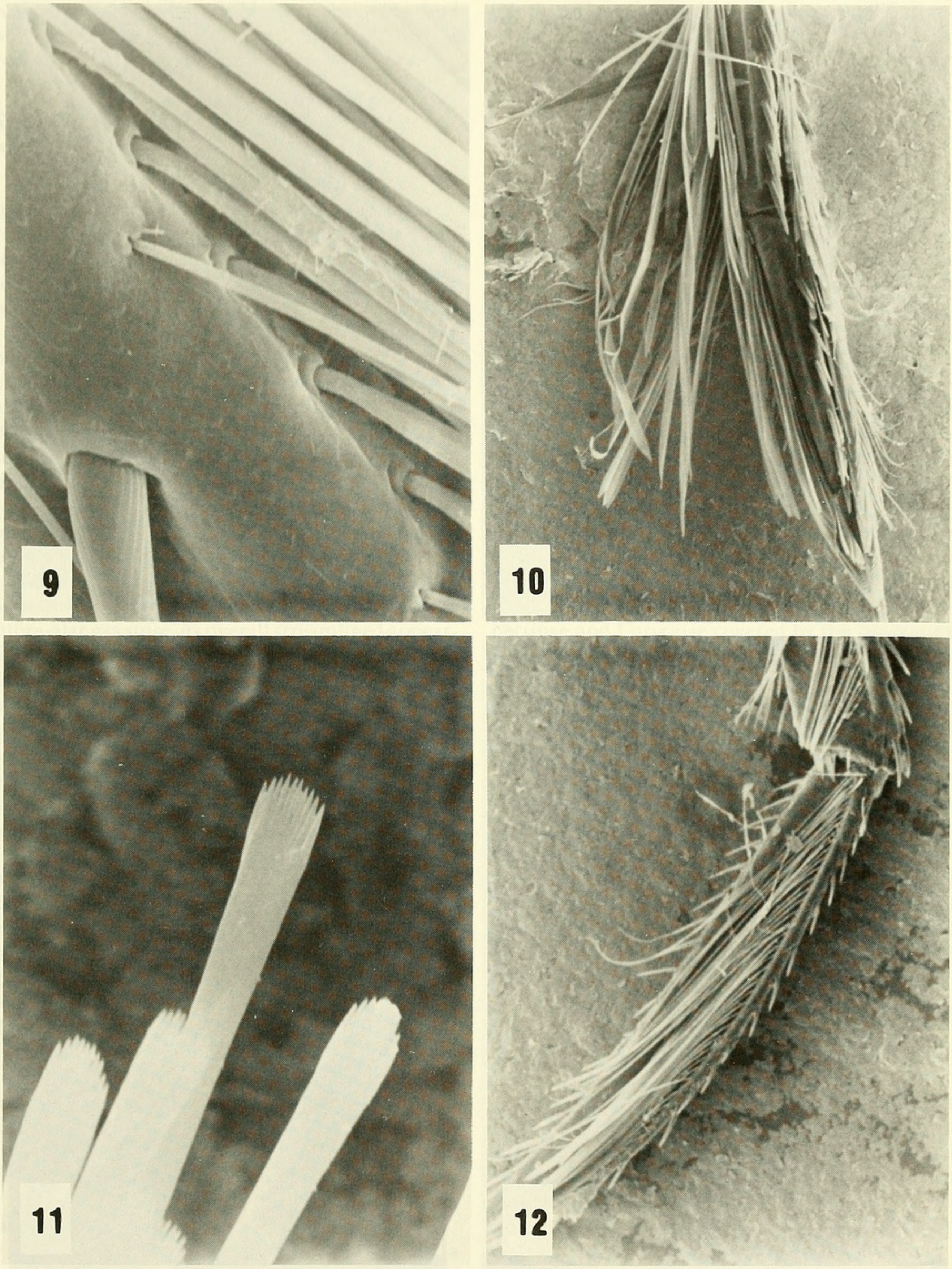
Diaprepocoris, cuticular blades and swimming hairs

The hind tarsi of *Diaprepocoris* have in addition to the rows of swimming hairs, fringes of cuticular blades as long or longer than their respective tarsal segments. When not in use, they overlie each other like a venetian blind (fig. 7). Fanned out they increase the surface area of the tibiae-tarsi. The spread of the blades increases the surface area of the 1st tarsus along the leading edge by 3.5×10 (this and following figures approximate) – trailing edge has a greater density of fine swimming hairs overlying a row of blades increasing the surface area by 10×2. The leading edge of 2nd tarsus has a row of blades decreasing in length distally, increasing surface area by 3.0×10 – trailing edge has fewer swimming hairs, the blades are roughly all the same length, increasing surfaces area by 2.0×10. The cuticular blades thus greatly increase the surface area (figs. 17, 18). According to Nachtigall (1974) cuticular blades create about 90% thrust of that of a solid object of equal size in the Gyrinidae (Coleoptera).

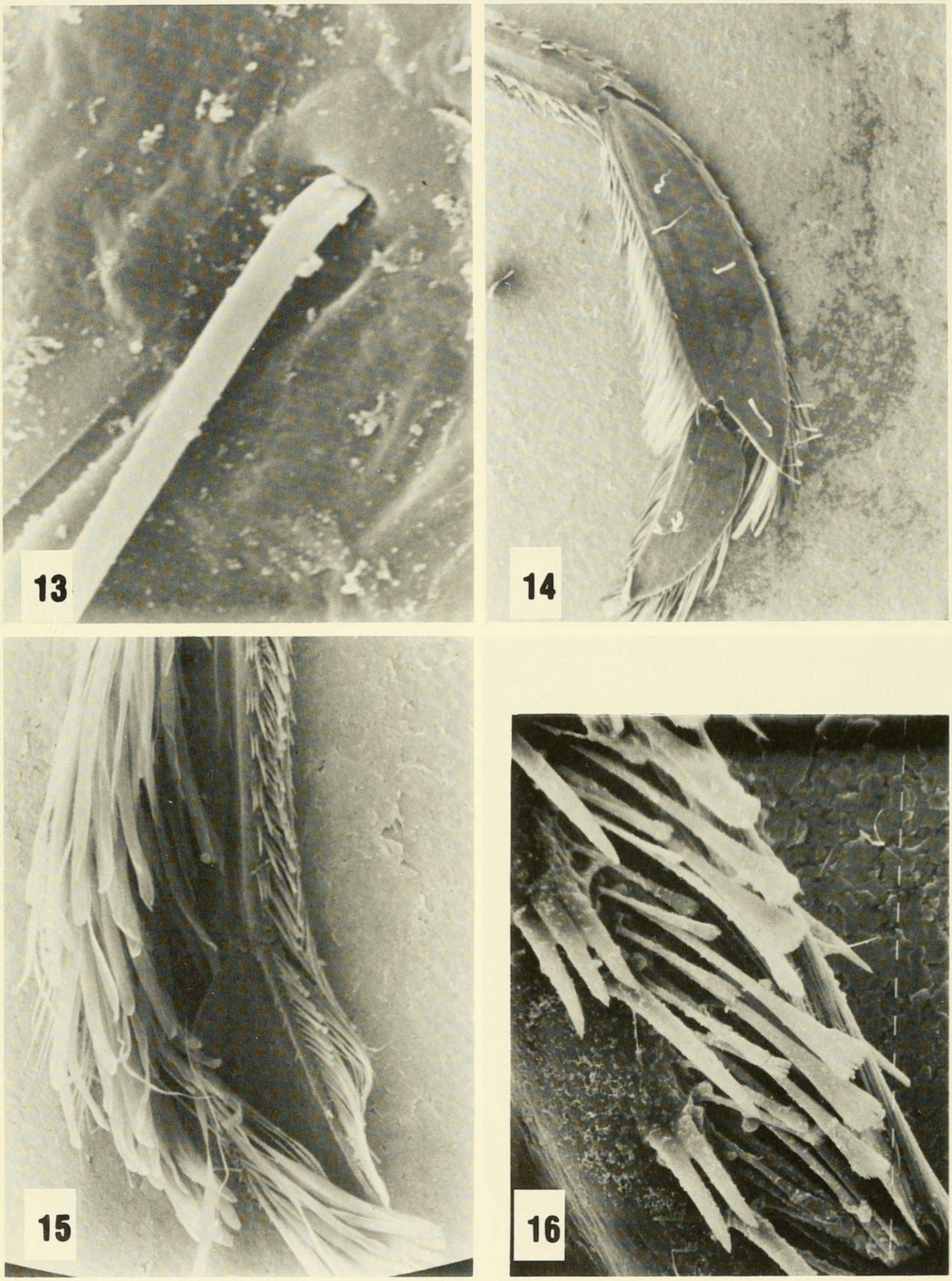
The blades of *Diaprepocoris* appear to have a function similar to those of gyrinids, the latter also use their middle legs when swimming. The hind coxae of *Diaprepocoris* conform to the usual corixid form. The ventral surface of the coxae is flattened to accommodate the trochanter-femur in the full recovery position, the femur forming a 33° angle with the midline of the body. The flattened area is partially enclosed by the tip of the metaxyphus and prevents excessive rotation of the hind leg (fig. 19). Schenke (1965, 1966) gives an account of a corixid swimming using *Corixa punctata* Illiger as a model. There are striking differences between the two genera. *Corixa* has a complex arrangement of rows of hairs, each with an incomplete basal ring, this enables the hairs to be folded flat against the leg during the recovery stroke. The tarsal hairs are supported by a row or rows of stout flexible spines which function in a similar fashion. There are few hind tarsal spines on *Diaprepocoris* compared with *Corixa*; *D. barycephala* 1st tarsus has between 10-13 spines in each of three lateral rows, one either side of the trailing edge and one along the leading edge. All the spines are semi-erect and probably rotate in much the same way as *Corixa*. The fringes of swimming hairs are arranged in a distinct manner. According to Schenke (1965) there are in excess of 5000 hairs on each rowing leg of *Corixa*. In *Diaprepocoris*, the leading edge of the 1st tarsus has about 30 long hairs, each having an incomplete basal ring (fig. 8) and a larger number along the trailing edge. Second tarsus with 8 long hairs along the leading edge and about 30 along the trailing edge. Figure 9 shows the incomplete basal rings of the cuticular blades in the recovery position, fig. 10 shows the folding of the blades on the 2nd tarsus partially overlapping the apical claws and extreme length of some of the blades. The hind tibiae moderately spinose (fig. 23) interspersed with hairs, some are expanded distally with a series of fine incisions (fig. 11). These modified hairs may reduce drag and loading on the hind legs, another function may be to move expired gas backwards over the elytra prior to the corixid surfacing to renew its gas store. The distribution of the explanate hind tibial hairs and cuticular blades of the tarsi are not uniform throughout the genus, *D. barycephala* (fig. 17), *D. personata* Hale (fig. 18) and *D. pedderensis* Knowles (figs. 20, 21). There is also variation in the development of the swimming



Figs. 5-8. *Diaprepocoris barycephala* Kirkaldy. – 5, outer lateral margins of corium and edge of double hair pile layer ×3200; 6, lateral margin of forewing at nodal furrow with scale-like surface ×800; 7, overlapping cuticular blades on hind tarsus ×200; 8, hind tarsi, note incomplete basal rings ×400. Reduction 84%.



Figs. 9-12. *Diaprepocoris barycephala* Kirkaldy. – 9, base of cuticular blades showing the incomplete basal rings ×800; 10, cuticular blades on hind tarsi, note extreme length of blades ×50; 11, incised hairs on the hind tibia ×800; 12, immature *Diaprepocoris*, hind tarsus ×50. Reduction 84%.



Figs. 13-16. *Stenocorixa protrusa* Horvath. – 13, elytra with single strap-like hair, note channel in elytra ×3200; 14, explanate hind tarsi with cuticular blades ×24; 15, explanate hind tarsi, note length and density of blades ×50; 16, incised hairs on hind tarsi ×400. Reduction 84%.

hairs on the middle legs; in *pedderensis* none are visible on a slide mounted leg (fig. 22), *personata* has about 20 hairs visible on the tibia and *barycephala* has about 50 hairs on the tibia and two rows of about 60 hairs on the tarsus.

Stenocorixa, cuticular blades and swimming hairs

The hind tarsi of *Stenocorixa* (fig. 14) are the most explanate of all the corixids, they most closely resemble those of *Lethocerus* (Belostomatidae, Heteroptera). The cuticular blades are extremely long forming a dense matted fringe (fig. 15). It has not been possible to determine from available preparations if each of the blades have an incomplete basal ring q.v. *Diaprepocoris* (fig. 9). The long swimming hairs fringing the rows of blades each appear to have incomplete basal rings. The trailing edge of the 1st tarsus has about 10 groups of stout semi-erect spines, between each group, a single thicker spine. The rows partially enclose several rows of long fan-shaped hairs which are deeply incised distally (fig. 16), it is likely that these hairs have a similar function to those of *Diaprepocoris*.

The fine structure of the clavus and corium of *Stenocorixa* does not suggest that it has a large supra-alar gas store, its overall streamlined appearance is totally different from that of *Diaprepocoris*. The complete basal rings would prevent the hairs laying flat against the forewings and would presumably cause minor eddies over the dorsum of the swimming corixid. The hairs are too few in number to act as a hydrofuge layer and may have some sensory function or be used for manouvering nektonically.

There is a rather greater degree of flexibility between the hind tibiae-tarsi than in *Diaprepocoris*. The hind tibiae of *Stenocorixa* have a pair of prominent projections distally. The acuminate insertion of the tarsus within the tibia suggests that there is considerable flexibility which would increase the corixids manouverability. The 2nd tarsus is capable of partial folding as in the Gyrinidae, this would be advantageous in the recovery stroke reducing drag. The hind legs of *Stenocorixa* are pro-rata much longer than those of *Diaprepocoris*.

Diaprepocoris: hind tibiae not explanate and not reaching the end of the abdomen.

Stenocorixa: hind femur-tibia-tarsus explanate, tibia reaching the end of the abdomen.

The power stroke of *Stenocorixa* may exert a greater propulsive effort, the folding hind tarsi reducing drag during the recovery stroke. The relative shortness of the hind legs of *Diaprepocoris* with possible reduction of energy in the power stroke may be compensated for by the supra-alar gas store, this would enable the corixid to stay submerged for longer periods, thus avoiding predators. The extra bouyancy would however, also mean that the corixid would need to keep up a high level of power strokes to maintain depth and attitude when submerged and not resting on submerged objects.

DISCUSSION

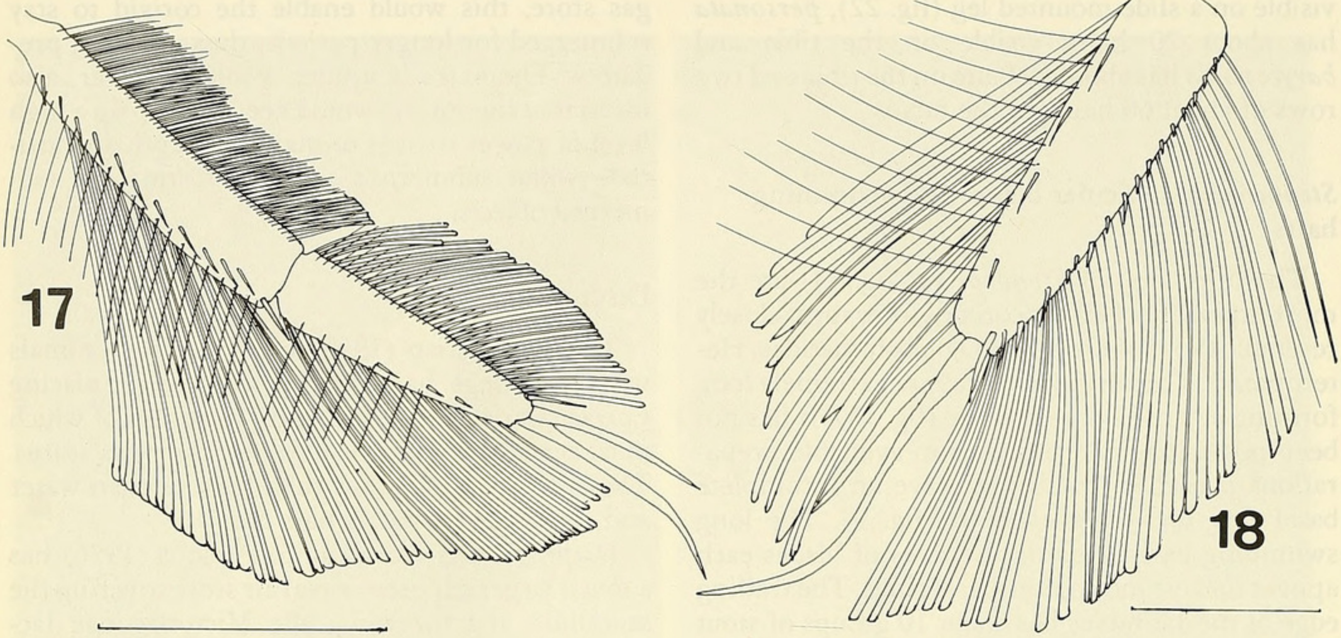
Thorpe & Crisp (1949) group aquatic animals with hydrofuge hairs in four categories, placing *Corixa* (Corixinae) in group III, members of which must surface at intervals to renew their gas stores. They are bouyant rather than heavier than water and often have a double hair pile.

Diaprepocoris according to Parsons (1976) has a much larger exposed dorsal air store covering the scutellum and forewing; the Micronectinae Jaczewski have the supra-alar store restricted to the anterior part of the embolium and the anteriormost part of the claval suture; the Corixinae Jaczewski have a slightly larger air store extending the length of the embolium, anterior part of the clavus suture and that part of the clavus covered by the pronotum. The mesonotal air store of the Micronectinae and Corixinae covered by the pronotum. As a form of air bubble respiration, *Diaprepocoris* has a much larger gas store than most other corixids, in addition to the supra-alar store, it has subalar gas stores beneath the forewings and over much of the venter.

The presence of large supra-alar air stores and sub-alar stores may increase the bouyancy of *Diaprepocoris*, the bouyancy levels possibly being related to the density of swimming hairs and cuticular blades on the hind legs. Possible secondary functions of the external gas layer may be either as a flexible skin which would enable the corixid to swim with less friction. With the exception of *D. pedderensis*, all *Diaprepocoris* species are relatively short and squat, their greatest width being just over half total length. An alternative function may be acoustic; Theiss (1982) has shown that in *Corixa*, the cervical air store i.e. air stores formed by the posterior and lateral parts of the head being flattened forming flanges which overlap the prothorax, are used in the generation and radiation of sound, thus the dual function of air stores has been demonstrated.

Taxonomy

Diaprepocoris and *Stenocorixa* are the most distinctive genera of the extant Corixidae. Characters common to both subfamilies are:



Figs. 17-18. *Diaprepocoris* hind tarsi. – 17, *D. barycephala* Kirkaldy, scale line 1 mm; 18, *D. personata* Hale, scale line 0.25 mm.

– Hind tarsi fringed with cuticular blades
– Little difference between the male and female palae

The Diaprepocorinae share a set of characters which distinguishes the subfamily from all others:
1. Ocelli on vertex between compounds eyes (fig. 24)
2. Fore tibia-tarsus fused (fig. 25)
3. Tarsal claws of hind legs apical (figs. 17, 18 and 21)
4. Muscle attachment to male genital capsule dorsal
5. Female ovipositor with a recognisable blade-like structure

The Stenocorixinae share a limited set of characters which distinguish the subfamily:
1. Clavus and corium smooth without microtrichia (fig. 13)
2. Clavus and corium with scattered long strap-like hairs
3. Abdominal asymmetry of male 6-7th tergites hardly differing from female
4. Male left paramere absent

Various proposals have been made regarding the validity of the corixid subfamilies. Leston (1955) partially summarised the proposals of China (1943) and Hungerford (1948) and observed that most authors treat the Corixidae as a monophyletic group. Popov (1971) altered this concept to include the Shurabellidae (*Shurabella lepyronopsis* Becker-Migdisova, Liassic fossil). The Corixoidea should be considered a holophyletic group sensu Ashlock (1971).

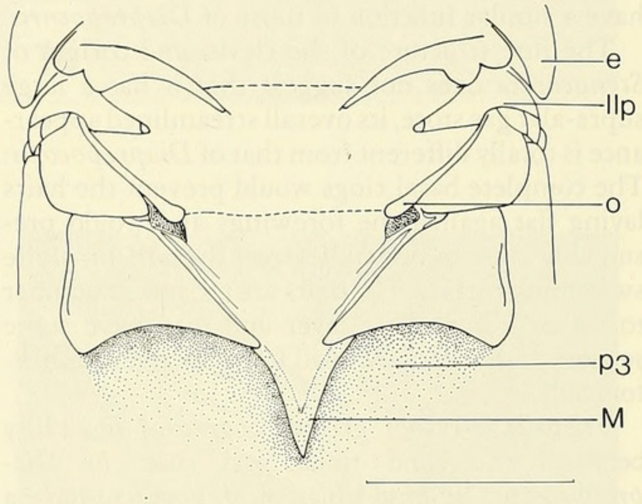
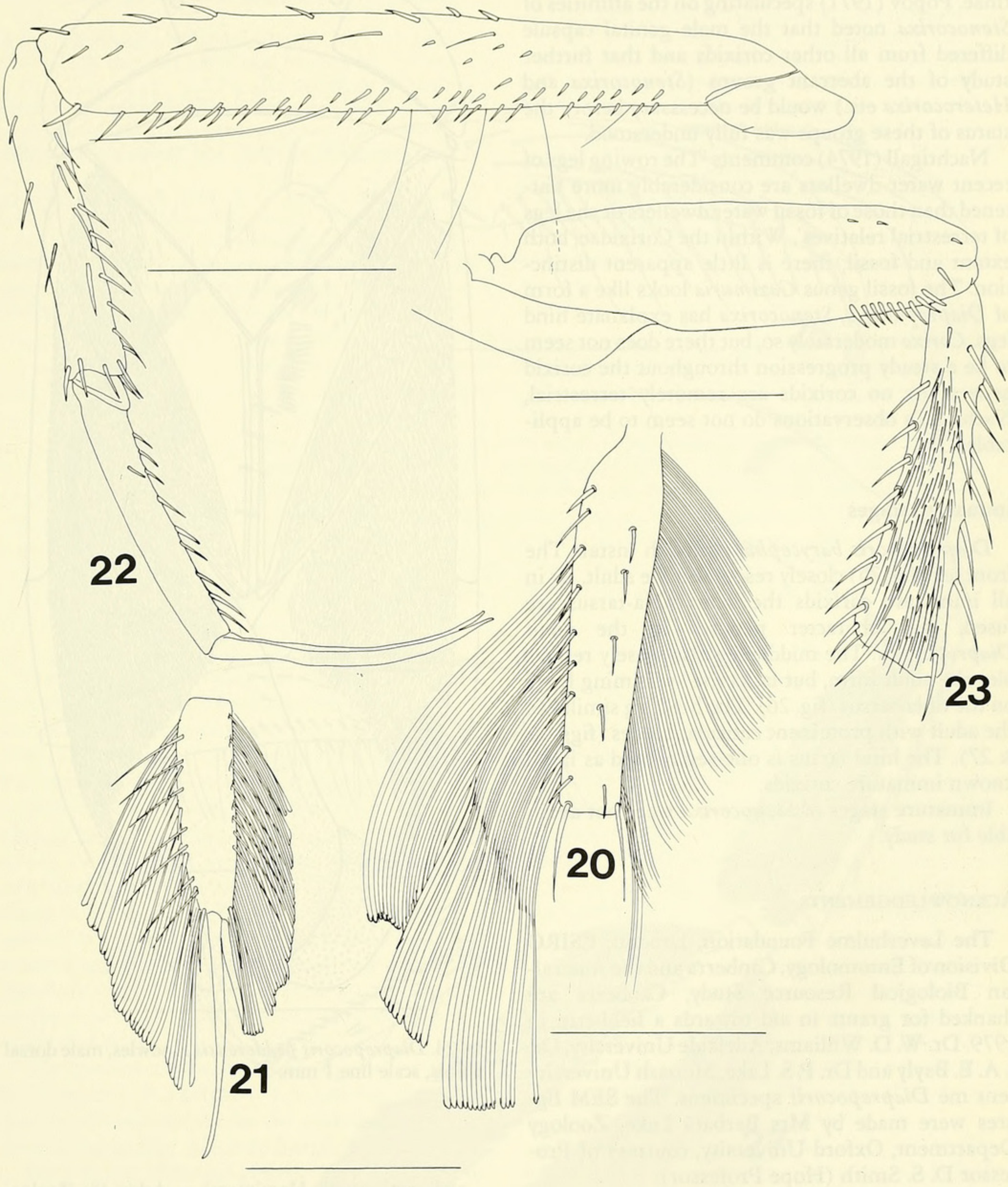


Fig. 19. *Diaprepocoris personata* Hale: metaxyphus and ancilliary structures. Abbreviations; e, eye; 11p, lateral lobe of prothorax; o, osteole of scent gland; P3, insertion of 3rd coxa; M, metaxyphus, scale line 1 mm.

Hungerford (1948) split the Corixidae into six subfamilies:
1. Groups with large exposed scutellum .... Diaprepocorinae and Micronectinae
– Groups with scutellum hidden 2
2. Hemielytral groove absent ..... Stenocorixinae
– Hemielytral groove present 3
3. Rostrum without transverse sulcations or nodal furrow, ... Cymatiinae
– Rostrum with transverse sulcations and nodal furrow .... Corixinae and Heterocorixinae



Figs. 20-23. *Diaprepocoris pedderensis* Knowles. – 20, 21, hind tarsi, scale line 1 mm; 22, middle leg, scale line 0.5 mm; 23, hind femur and tibia, scale line 0.5 mm.

Popov (1986) recognised three extant subfamilies viz. Corixinae, Diaprepocorinae and Micronectinae. Popov (1971) speculating on the affinities of *Stenocorixa* noted that the male genital capsule differed from all other corixids and that further study of the aberrant groups (*Stenocorixa* and *Heterocorixa* etc.) would be necesssary before the status of these groups was fully understood.

Nachtigall (1974) comments 'The rowing legs of recent water dwellers are considerably more flattened than those of fossil water dwellers or the legs of terrestrial relatives'. Within the Corixidae, both extant and fossil, there is little apparent distinction. The fossil genus *Gazimuria* looks like a form of *Diaprepocoris*, *Stenocorixa* has explanate hind legs, *Corixa* moderately so, but there does not seem to be a steady progression throughout the corixid genera. As no corixids are remotely terrestrial, Nachtigal's observations do not seem to be applicable.

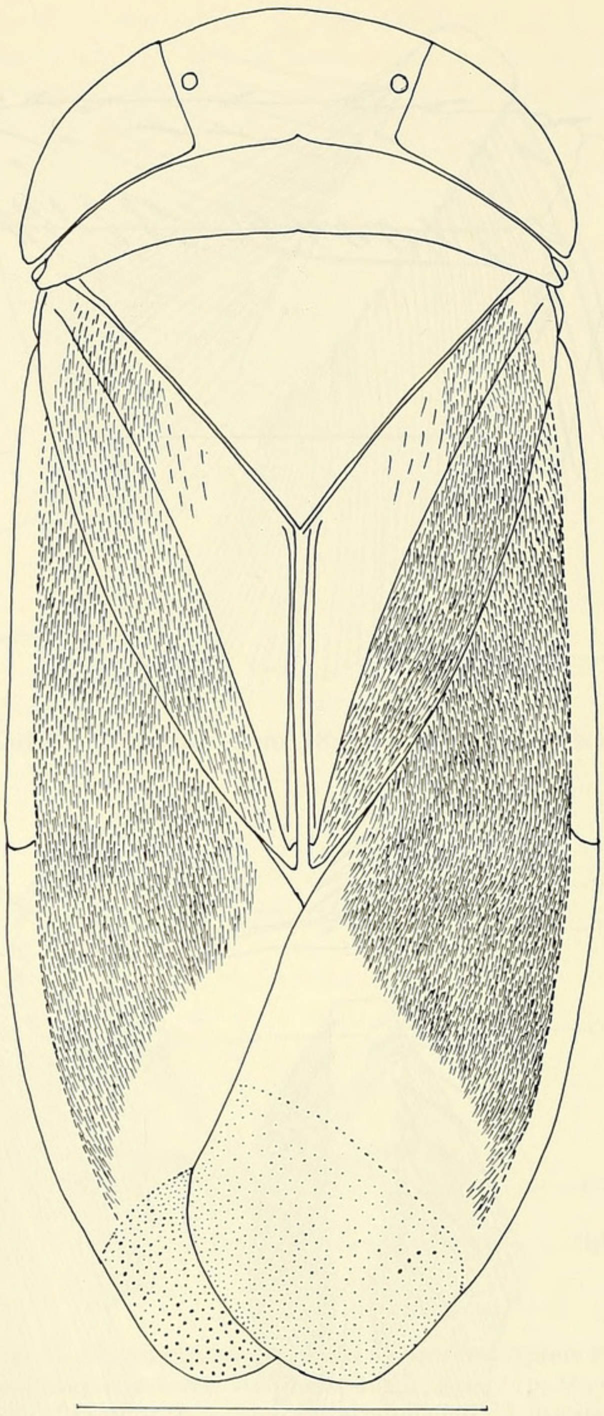


Fig. 24. *Diaprepocoris pedderensis* Knowles, male dorsal habitus, scale line 1 mm.

Immature stages

Diaprepocoris barycephala 4th-5th instar: The front leg (fig. 25) closely resembles the adult. As in all immature corixids the front tibia-tarsus are fused, this character persists in the adult *Diaprepocoris*. The middle leg also closely resembles the adult form, but lacks the swimming hairs on the tibia-tarsus (fig. 26). The hind leg similar to the adult with prominent cuticular blades (figs. 12 & 27). The hind tarsus is one-segmented as in all known immature corixids.

Immature stages of *Stenocorixa* were not available for study.

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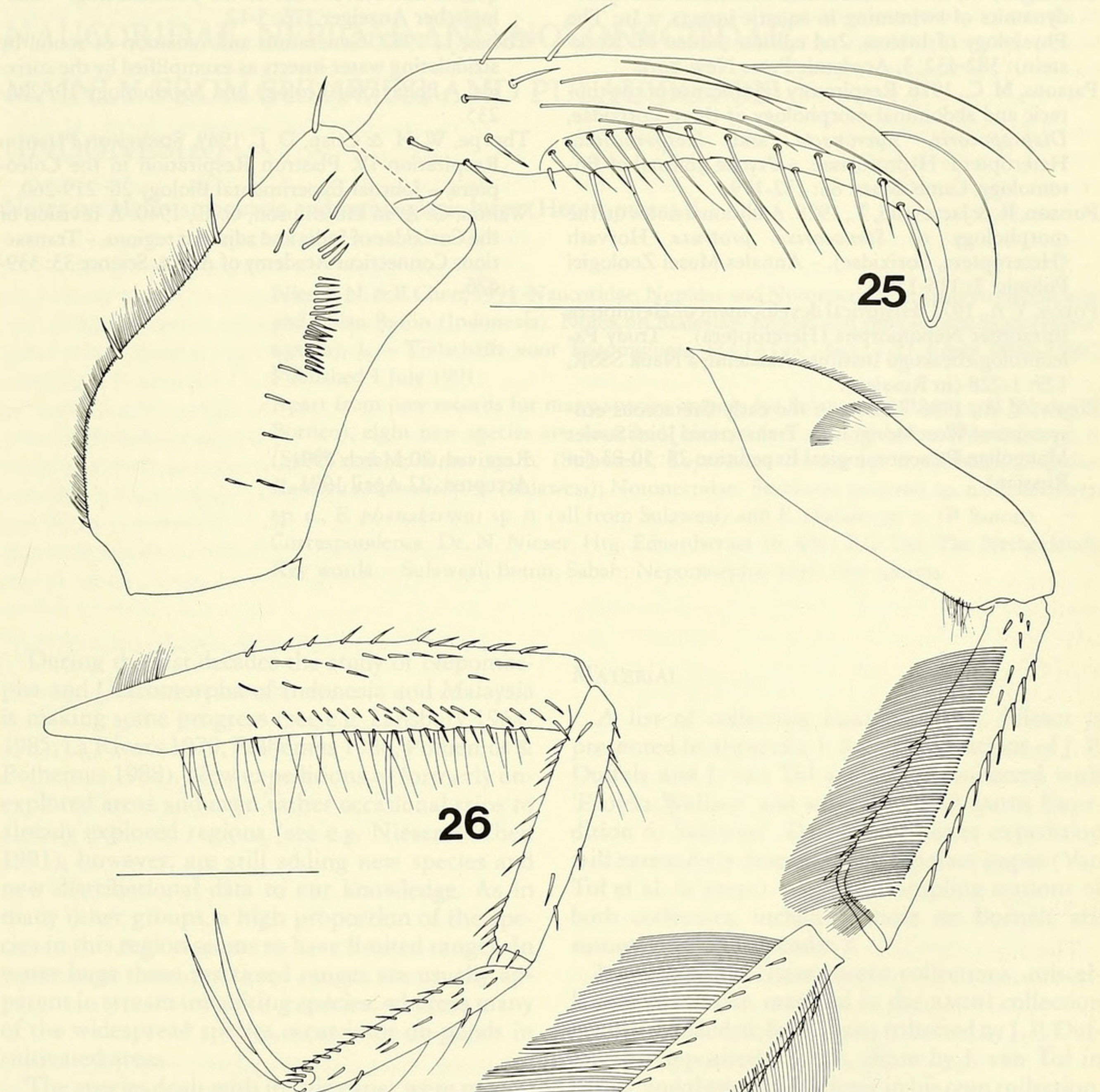

Figs. 25-27. *Diaprepocoris barycephala* Kirkaldy, immature. – 25, front leg, scale line 0.5 mm; 26, middle leg; 27, hind leg, scale line 0.5 mm.

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