

The three taro planthoppers: species recognition in *Tarophagus* (Hemiptera: Delphacidae)

MANFRED ASCHE

FB Biologie-Zoologie, Philipps Universität, P.O. Box 1929, Lahnberge, D-3550 Marburg, German Federal Republic

MICHAEL R. WILSON

CAB International Institute of Entomology, c/o British Museum (Natural History), London, SW7 5BD, UK

Abstract

The taro-feeding delphacid genus *Tarophagus* is revised. Three species are recognized: *T. colocasiae* (Matsumura) stat. rev. & comb. n. with which *T. proserpina taiwanensis* Wilson is synonymized; *T. persephone* (Kirkaldy) with which *T. proserpinoides* (Muir) and *T. proserpina australis* Fennah are synonymized; and *T. proserpina* (Kirkaldy). The three species are separated by characters of the male and female genitalia, and each has a different distribution in Asia and the Pacific. Only in Papua New Guinea are all three species sympatric. Earlier studies on biology and pest status are reviewed in the light of these investigations.

Introduction

The edible root taro (*Colocasia esculenta*) is an important food crop in the Pacific and is widely grown, both in the Pacific and elsewhere in Asia. Its future potential as a source of edible starch was reviewed by Wang (1983).

A number of insect pests, fungal and virus diseases damage the crop (Jackson, 1980; Mitchell & Maddison, 1983). One of the more important pests of the crop is the delphacid known as the 'taro planthopper' (or 'taro leafhopper' in some literature). Most records are given as *Tarophagus proserpina* (Kirkaldy), and it is recorded under this name from Malaysia, to Taiwan, to Australia and across the Pacific to Hawaii and Tahiti (e.g. CIE, 1972). The taro plant is damaged by direct feeding, but '*T. proserpina*' is also suspected of being the vector of alomae and bobone virus diseases (Jackson, 1980; Mitchell & Maddison, 1983). Waterhouse & Norris (1987) summarize the biology and distribution in the Pacific and emphasize the attempts at biological control (see section on Biology and pest status below).

Widespread geographical variation in the male genitalia structures of '*T. proserpina*' suggested that more than one species was involved with separate but partially overlapping distributions. The present study, based on specimens throughout the range of the genus, resolves the situation. Three morphologically different taxa are distinguished. The consequences of our modified concept of the species are given below. Earlier studies on biology and pest status are reviewed in the light of these investigations.

The material examined is deposited in the following collections:

BMNH British Museum (Natural History), London, UK.

- BPBM Bernice P. Bishop Museum, Honolulu, Hawaii, USA.
 IRSNB Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium.
 MA Manfred Asche, Fachbereich Biologie-Zoologie, Philipps Universität, Marburg,
 German Federal Republic, private collection.

Tarophagus Zimmerman

Tarophagus Zimmerman, 1948: 245–247; Fennah, 1965: 37. Type-species *Megamelus proserpina* Kirkaldy, by original designation.

The genus *Tarophagus* was erected by Zimmerman (1948) for *Megamelus proserpina* Kirkaldy, 1907 (the type species), described from Fiji, *M. persephone* Kirkaldy, 1907, from Australia (Queensland), and *M. proserpinoides* Muir, 1917, from Mindanao in the Philippines. Matsumura (1920) described *Liburnia (Delphax) colocasiae* from Formosa, which later was synonymized by Ishihara (1949) with *M. proserpina*. Fennah (1965) added the subspecies *T. proserpina australis* from Queensland, Australia.

Zimmerman (1948) based his generic concept of *Tarophagus* mainly on comparisons with superficially similar *Megamelus* s.s. species. Accordingly, a re-description and new definition of the genus is necessary.

Description. Small to medium-sized chestnut- to blackish-brown delphacids with a broad creamy-white or pale yellowish longitudinal stripe from vertex over dorsal discs of pro- and mesonotum to tip of scutellum; broad whitish or yellowish, distinctive dorso-median patches on the posterior three tergites (7–9), laterotergites yellow.

Vertex medially about as long as broad at base, lateral margins straight, anteriorly slightly converging; basal compartments about 0.6 times the length of vertex, median carina weak or missing, area shallowly concave; apical cell distinct. Frons about twice as high as broad, maximum width at frontoclypeal suture; carinae of frons prominent, median carina forked in upper quarter; frontal area shallowly concave, in basal portion almost flat. Post- and anteclypeus together little shorter than frons, surface convex; median carina of

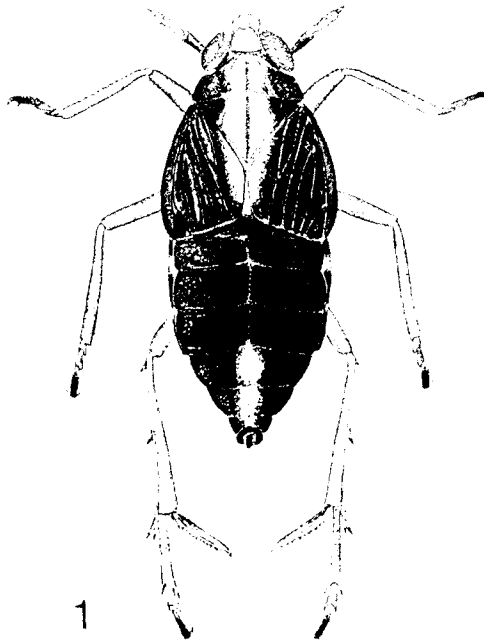


Fig. 1.—*Tarophagus proserpina* (Kirkaldy) adult ♂ (brachypterous).

postclypeus distinct. Rostrum attaining anterior margin of postcoxae. Antennal segments cylindrical, 2nd joint slightly longer than 1st (1.1–1.2:1); number and arrangement of sensory fields of pedicel: 16 in 7 groups or rows. Ocelli and blemmata present, ocelli in brachypterous forms slightly reduced. Pronotum wider than head (1.2:1); in middle line about as long as vertex; carinae distinct, lateral pair straight, diverging caudad, reaching the posterior margin of the pronotum. Mesonotum medially longer than pronotum (1.6:1), lateral carinae straight, diverging caudad, median carina weak, extinct at tip of scutellum. Post-tibial spur foliate with about 28–36 minute teeth. Postbasitarsus about 1.6–1.7 times longer than post-tarsal segments II and III together, apically with 7 (2 + 5) spines; apex of post-tarsal segment II with 4 spines in row. Tegmina of macropterous form longer than abdomen, slightly translucent, brownish; about 3.7 times longer than broad; *Sc* + *R* and *Cu*₁ branching at the same level shortly distad of middle, interior subapical cell slightly longer than exterior; veins with minute granules. Hind wings semihyaline with pale brownish veins. Tegmina of brachypterous form strongly reduced, distally truncate, not exceeding abdominal tergite III.

Male genitalia. Genital segment ventrally longer than dorsally (about 2:1), latero-dorsal angles slightly produced, lobe-like, especially in dried specimens bent mediad; ventrocaudal margin trilobate; dorsal margin of diaphragm V- or U-shaped. Parameres short, diverging. Anal segment collar-like with a pair of spinose processes. Aedeagus tubular, laterally slightly compressed, curved ventrad, distally armed with a pair of flag-like, cephalad-reflected, spinose processes originating from a common base on the right side of the apex; phallosome subapical on the dorsal side. Connective straight or slightly curved cephalad, broadly fused with the ventral side of the basal chamber of the aedeagus. Suspensorium long, plate-like, dorsally Y-shaped, arms of Y rather short.

Female genitalia. Posterior margin of the central membranous part between the sclerites of sternite VI dilated to a plate-like scale which medially is divided into two movable parts. From the posterior margin of sternite VII arises a small, clasp-like genital scale. Median gonapophyses IX (II. valvulae) dorsally in their distal third with numerous minute teeth forming a saw.

Remarks. *Tarophagus* species can be easily recognized by their distinctive colour pattern on the vertex-thorax and the apex of abdomen, by the trilobate margin of the male genital segment and by a movable double-scale-like process of abdominal sternite VI of the females.

Tarophagus belongs to a large and probably monophyletic group of taxa which includes *Perkinsiella* Kirkaldy, *Euidopsis* Ribaut, *Thriambus* Fennah and *Nycheuma* Fennah. These taxa share several synapomorphies including the general shape of the aedeagus (distally flag-like reflected), a Y-shaped suspensorium (although the dorsal arms of the Y in *Tarophagus* are rather short), the broad fusion of the connective with the basal aedeagus-chamber and in the male drumming organ the secondarily reduced, shell-like apodemes of abdominal sternite II. However, the position of *Tarophagus* within this group is still unclear. In the trilobate ventrocaudal margin of the male genital segment, *Tarophagus* resembles to a certain extent *Nycheuma* species, also *Malaxodes* Fennah and some *Thriambus* species.

Zimmerman (1948) claimed to have seen further "new species which belong to *Tarophagus*", unfortunately without giving any details. The three morphological species of *Tarophagus* recognized from our investigation can be distinguished by the following keys. Only characters of the male and female genitalia are useful to distinguish the species.

KEY TO MALES OF *Tarophagus*

- 1 Genital segment with lateral pair of ventrocaudal processes tapering, cone-shaped, distally slightly curved mesad (Fig. 15); parameres straight, truncate at apex (Fig. 20); anal segment with spinose processes rather long (Figs 18, 21); aedeagus with reflected flag-like process broadly fused at base, at apex bifurcate in two equal spines (Figs 18, 19) *T. persephone* (Kirkaldy)

- Genital segment with lateral pair of ventrocaudal processes broad, plate-like (Figs 24, 4); parameres in distal third bent laterad (Figs 26, 27, 7); anal segment with spinose processes short and stout (Figs 28, 31, 11, 12); aedeagus with reflected flag-like processes separate until base (Figs 28–30, 8–11) 2
- 2 Genital segment with lateral ventrocaudal processes laterodistally projected in a pointed tip, medioventral process shorter than the lateral ones (Fig. 24); aedeagus with reflected processes in lateral view almost parallel to each other, shaft smoothly curved ventrad (Figs 28, 29) *T. proserpina* (Kirkaldy)
- Genital segment with lateral ventrocaudal processes laterodistally rounded, distal margin slightly produced medially forming an acute inner edge; medioventral process longer than the lateral ones (Fig. 4); aedeagus with reflected processes diverging, the longer right spine distally pointing dorsocaudad (Figs 9–11) *T. colocasiae* (Matsumura)

KEY TO FEMALES OF *Tarophagus*

- 1 Valvifer VIII with bases medially broadly rounded (Fig. 14); abdominal sternite V with median membrane between the chitinized parts without paired chitin-plates, sternite 6 with movable double-scale, medially asymmetrically notched (Fig. 13) *T. persephone* (Kirkaldy)
- Valvifer VIII with bases produced mediocephalad or mesad in a pointed or finger-shaped tip; sternite V with median membrane between the chitinized parts with two separated chitin-plates (Figs 22, 23, 2, 3); sternite VI with movable double-scale medially with a straight incision 2
- 2 Valvifer VIII with inner margin of the bases produced mediocephalad forming a short, triangular tip (Fig. 23) *T. proserpina* (Kirkaldy)
- Valvifer VIII with inner margin of the bases produced in a long, finger- or tongue-like process (Fig. 3) *T. colocasiae* (Matsumura)

Tarophagus colocasiae (Matsumura) **stat. rev. & comb. n.** (Figs 2–12)

Liburnia (*Delphax*) *colocasiae* Matsumura, 1920: 564; Matsumura, 1932: 225. Type series from Taiwan, not examined; apparently in the collections of the Entomological Institute, Hokkaido University, Sapporo, Japan.

Delphacodes ?*colocasiae* (Matsumura); Esaki & Ishihara, 1943: 36.

Megamelus proserpina Kirkaldy; misinterpreted by Fullaway, 1937: 405; Esaki, 1940: 278; Esaki & Ishihara, 1943: 19; Matsumura & Ishihara, 1945: 71; Ishihara, 1949: 78–79. (Ishihara, 1949, synonymized *T. colocasiae* with *T. proserpina*.)

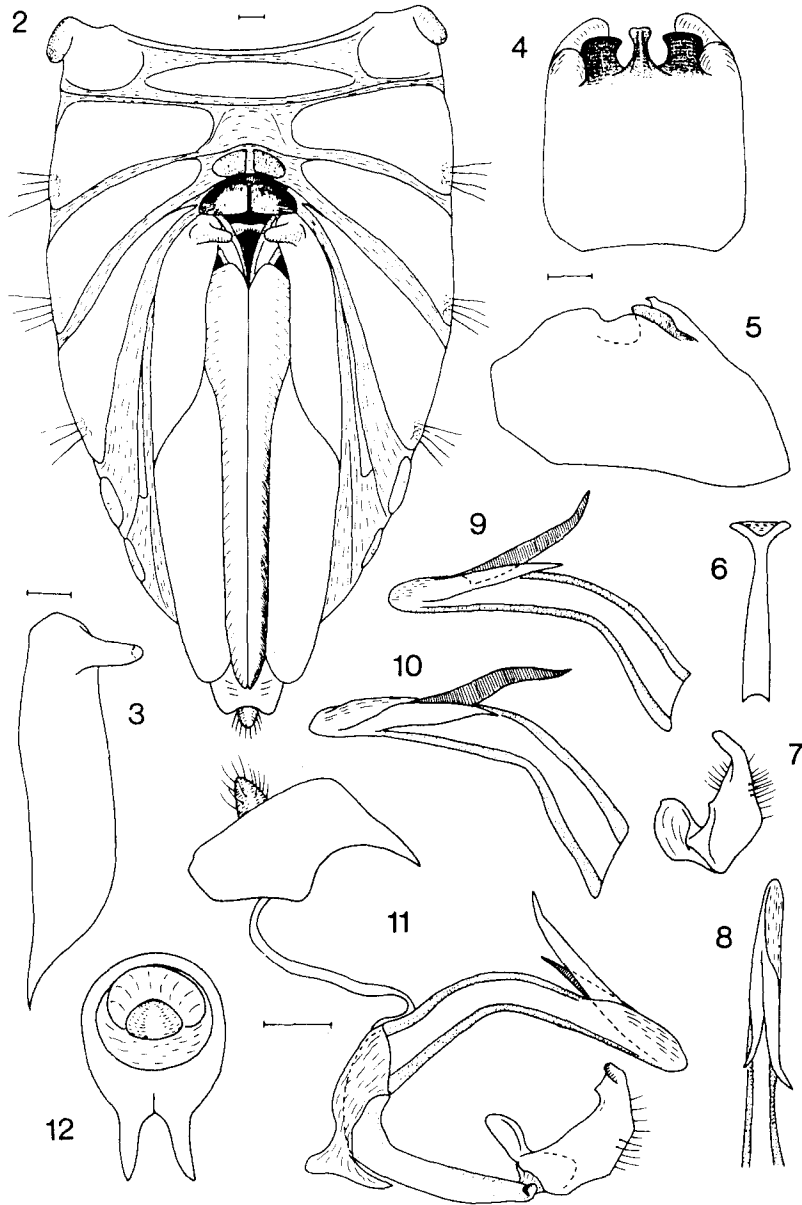
Tarophagus proserpina (Kirkaldy); misinterpreted by Zimmerman, 1948: 247, partim; Fennah, 1956: 110–111; Fennah, 1970: 60; Fennah, 1971: 571; ?Fennah, 1978: 16.

Tarophagus proserpina taiwanensis Wilson in Wilson & Tsai, 1988: 54. **Syn n.**

Distribution. Apparently widely distributed all over South-East Asia, extending eastwards to the Pacific north of the equator from Belau (=Palau) Is to Guam over Micronesia and the Marshall Is to Hawaii.

Material examined. Numerous specimens from Indonesia (Java), Borneo, Philippines, Papua New Guinea, New Britain, Solomon Is (BMNH, BPBM), Indonesia (Sulawesi) (BMNH, IRSNB, MA), Indonesia (Ambon) (BPBM), Thailand, Taiwan, Belau, Guam, Micronesia (Ponape, Yap, Truk), Marshall Is (Kili, Namorik) and Hawaii (BPBM).

Remarks. Although the authors have not examined the type-material of *T. colocasiae*, there is little doubt that the Taiwanese species cannot be *T. proserpina*, which does not occur in this part of Asia. Moreover, we have no evidence for the occurrence of *T. persephone* in Taiwan. The Taiwanese specimens examined (and apparently also samples recently collected by C. T. Yang, Chung Hsing University, Taiwan (pers. comm.), belong to only one species which has to be named *T. colocasiae*. The synonymy of *T. proserpina*



Figs 2-12.—*Tarophagus colocasiae* (Matsumura), specimens from Philippines and Solomon Is; 2, ♀ genitalia, ventral view (Solomon Is); 3, ♀ genitalia, right valvifer VIII; 4-12 (Philippine Is). 4, ♂ pygofer, ventrocaudal view; 5, genital segment in lateral view; 6, suspensorium; 7, paramere, ventral view; 8, tip of aedeagus, dorsal view; 9, aedeagus, right lateral view (Philippine specimen); 10, aedeagus, right lateral view (Solomon Is specimen); 11, anal segment, aedeagus and parameres, left lateral view; 12, anal segment, caudal view. (Scale lines = 0.1 mm.)

taiwanensis (Wilson in Wilson & Tsai, 1988) has been based on the description and drawings given in that paper.

This species can be distinguished from the other *Tarophagus* species by the shape of the ventrocaudal lobes of the male genital segment, which are laterodistally broadly rounded (Fig. 4), and by the diverging reflected processes (in lateral view) of the aedeagus (Figs 9–11), and in the female genitalia by the finger-shaped basal process of valvifer VIII and the strongly developed double-scale of abdominal sternite VI which is about double the size of that of *T. proserpina* (Figs 2–3).

Intraspecific variation is found in the shape and size of the ventrodial processes of the male genital segment (Fig. 32).

***Tarophagus persephone* (Kirkaldy) (Figs 13–21)**

Megamelus persephone Kirkaldy, 1907: 148. Holotype ♂, AUSTRALIA: Queensland (BPBM) [examined].

Megamelus proserpinoides Muir, 1917: 327. Holotype ♂, PHILIPPINES: Mindanao (BPBM) [examined]. **Syn. n.**

Tarophagus proserpina australis Fennah, 1965: 37–39. Holotype ♂, AUSTRALIA: Queensland (BMNH) [examined]. **Syn. n.**

Distribution. Widespread in South-East Asia and Australia.

Material examined. Numerous examples from Australia (Northern Territory (MA), Queensland), Papua New Guinea, Borneo, Philippines (BMNH, BPBM), Solomon Is (BMNH), New Britain, Malaysia (BPBM) and Indonesia (N. Moluccas (Ternate) (BMNH), Sulawesi (BMNH, IRSNB, MA)).

Remarks. *T. persephone* can be distinguished from the two other *Tarophagus* species by the following characters: in the male genitalia, by the cone-shaped lateral ventrocaudal processes of the genital segment (Fig. 15), by the straight and distally truncate parameres (Fig. 20), by the distally widely bifurcate and basally broadly fused reflected processes of the aedeagus (Figs 18, 19) and by the rather long processes of the anal segment (Figs 18, 21); in the females, by the absence of paired chitin-plates in the median membranous part between the sclerites of abdominal sternite V (Fig. 13) and by the lack of basal projections of valvifer VIII (Fig. 14). The double-scale of abdominal sternite VI is asymmetrically incised in middle (Fig. 13).

The range of intraspecific variation of the ventrocaudal processes of the male genital segment is shown in Fig. 33.

***Tarophagus proserpina* (Kirkaldy) (Figs 22–31)**

Megamelus proserpina Kirkaldy, 1907: 147–148. Hopkins, 1927: 24; Muir, 1927a: 10; Muir, 1927b: 87. Holotype ♂, allotype ♀, FIJI (BPBM) [examined].

Tarophagus proserpina (Kirkaldy); Fennah, 1950: 45; Fennah, 1958: 194; Fennah 1969: 21.

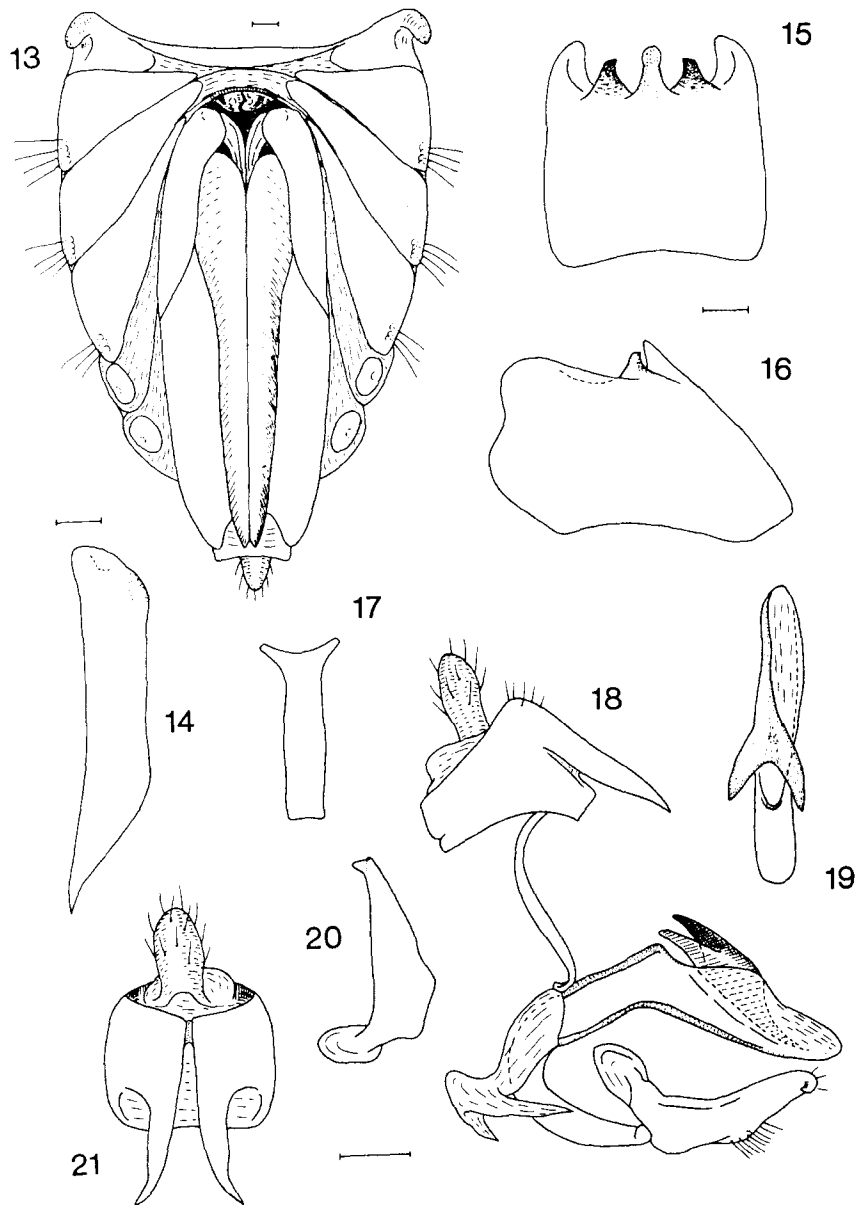
Distribution. Widespread in the Pacific south of the equator from north-eastern Papua New Guinea in the west across the southern Pacific islands to Tahiti in the east.

Material examined. Numerous specimens from Papua New Guinea, Vanuatu, Fiji, Western Samoa (Savaii, Upolu), American Samoa (Tutuila), Society Is (Raiatea, Tahiti) (BMNH, BPBM), New Caledonia, Cook Is and Niue (Savage Is) (BPBM).

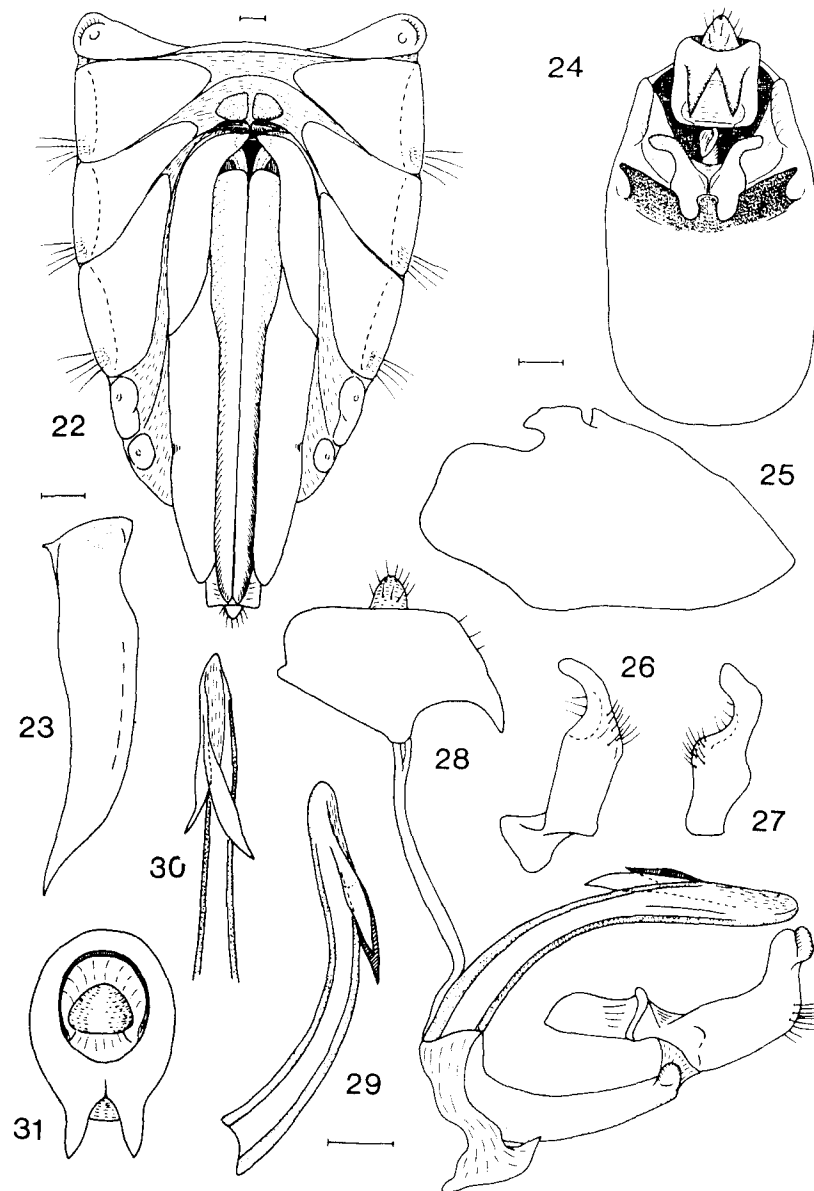
'*T. proserpina*' has also been recorded from Tonga by Hopkins (1927). The record undoubtedly concerns this species as Tonga lies well within the distribution of the newly defined *T. proserpina*.

Remarks. *T. proserpina* is characterized by the following characters of the male and female genitalia:

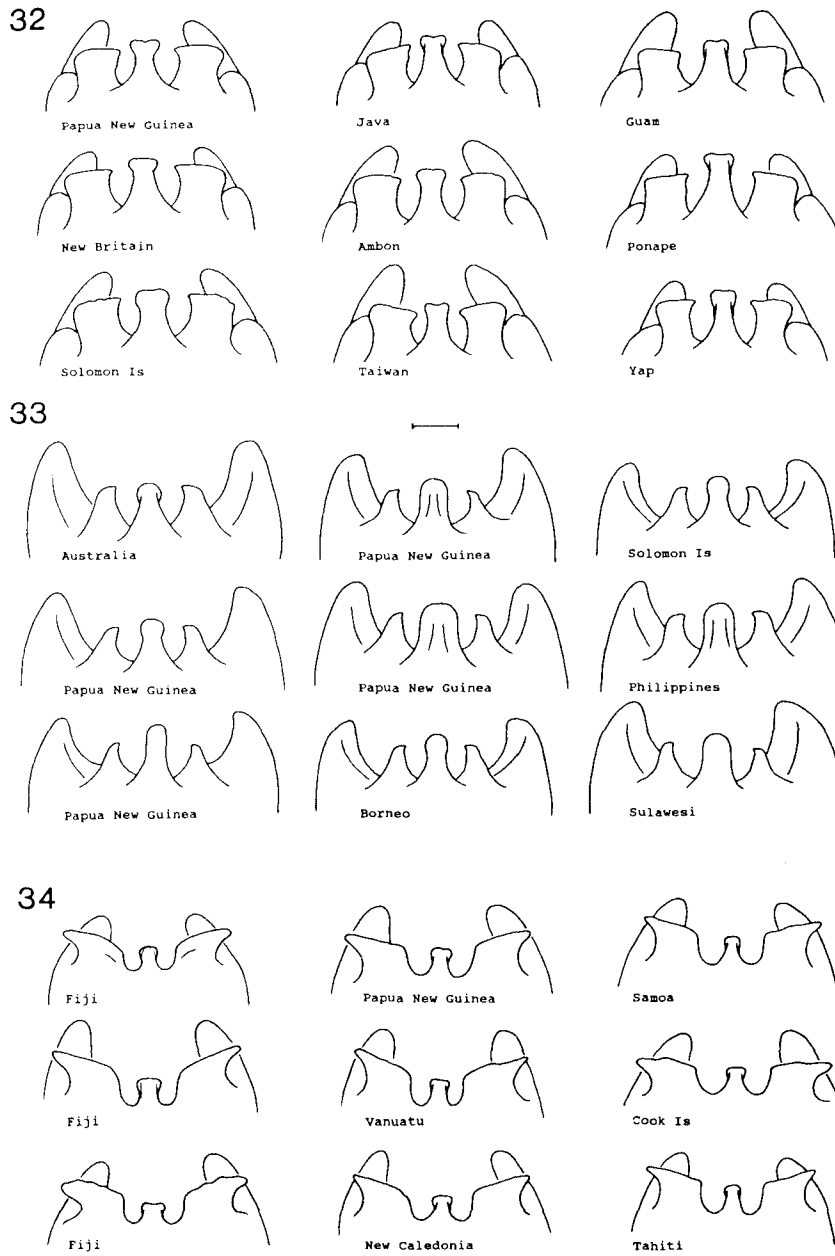
In males, the ventrolateral lobe-like processes of the genital segment are produced and tapering laterocaudad, the medioventral process is always shorter than the lateral lobes (Fig. 24); the parameres are distally narrowed to a finger-like tip and curved laterad (Figs



Figs 13–21.—*Tarophagus persephone* (Kirkaldy), ♀ from Borneo, ♂ from Australia; 13, ♀ genitalia, ventral view; 14, ♀ genitalia, right valvifer VIII, 15, ♂ pygofer, ventrocaudal view; 16, pygofer, left lateral view; 17, suspensorium; 18, anal segment, aedeagus, and parameres, left lateral view; 19, tip of aedeagus, dorsal view; 20, paramere, ventral view; 21, anal segment, caudal view. (Scale lines = 0.1 mm.)



Figs 22–31.—*Tarophagus proserpina* (Kirkaldy), Specimens from Fiji (type locality). 22, ♀ genitalia, ventral view; 23, ♀ genitalia, right valvifer VIII; 24, ♂ genitalia ventrocaudal view; 25, genital segment in lateral view; 26, paramere, ventral view; 27, paramere, ventrolateral view; 28, ♂ genitalia, anal segment, aedeagus and parameres, left lateral view; 29, aedeagus, right lateral view; 30, tip of aedeagus, dorsal view; 31, anal segment, caudal view. (Scale lines = 0.1 mm.)



Figs 32-34.—Variation in ventrocaudal processes of genital segment in *Tarophagus* species from various localities; 32, *T. colocasiae*; 33, *T. persephone*; 34, *T. proserpina*.

26, 27); the shaft of the aedeagus is smoothly curved ventrad, the two reflected distal processes in lateral view almost parallel to each other, in caudal view slightly diverging (Figs 8–10); the processes of the anal segment are rather short, distally slightly diverging (Figs 8, 11). Little intraspecific variation is found in the shape of the lateral ventrocaudal lobes of the male genital segment (Fig. 34).

In females, two small chitin-plates are present in the central membrane between the sclerites of abdominal sternite V (Fig. 2); centrally between the sclerites of abdominal sternite VI is a movable double-scale system which in repose is directed caudad and covers the cephal part of the entrance to the genital chamber, an incision dividing the two parts of the scale with a straight margin (Fig. 22); the bases of valvifer VIII are projected to a mediocephalad directed, blunt tip (Fig. 3).

It is worth mentioning that Zimmerman (1948) did not figure a specimen collected in Hawaii but a paratype of *T. proserpina* from Fiji.

Discussion

As shown in the keys and as illustrated, all three *Tarophagus* species are well distinguished by genital characters. As interpreted, the range of intraspecific variation within each species is surprisingly low, both within a population and geographically. Examples for intraspecific variation in the trilobate ventrocaudal margin are given in Figs 32–34. In *T. colocasiae*, slight variation could also be found in the length and direction of the basal processes of valvifer VIII and in the shape of the longer process of the reflected aedeagus flag (Fig. 10, specimen from the Solomon Is).

T. proserpina and *T. colocasiae* are apparently sister species. The following characters are interpreted as synapomorphic: the broad, plate-shaped lateral processes of the ventrocaudal margin of the genital segment (instead of the cone-shaped configuration in *T. persephone* which is considered to be plesiomorphic), the distally curved parameres (straight, i.e. plesiomorphic in *T. persephone*), the presence of paired chitin-plates in the median membranous part between the sclerites of sternite 5 (missing in *T. persephone*, probably the plesiomorphic state) and the basal projection of the inner margin of valvifer 8 (plesiomorphic, rounded without projection in *T. persephone*). *T. persephone* itself is characterized by the basal fusion of the two reflected spinose processes of the aedeagus, probably an autapomorphy.

The extent of speciation and the range of intraspecific variation within the genus *Tarophagus* has been studied by comparative morphology. It would be fascinating to study populations by biosystematics or by their acoustic behaviour (as reviewed by Claridge, 1985) or genetics, to examine further differentiation in this genus.

Distribution

Following these morphological findings, the geographical distribution of *Tarophagus* species has to be reconsidered (see Table I & Fig. 35). In contrast to Fennah's statement (1965) that he had "not seen any two examples of this genus that differ in the trilobate margin of the pygofer and occur side by side in the same area", we found several cases of sympatry and even of syntopy (same locality) between differently shaped specimens which in fact represent two or, in Papua New Guinea, even three species. The distributions of only *T. persephone* and *T. colocasiae* overlap over a wide range in South-East Asia. So far as is known at present, that of *T. proserpina* overlaps only in Papua New Guinea (north-eastern provinces only) with those of the two other species. In all these overlapping zones, no evidence for hybrid belts or clines could be found. However, in *T. proserpina*, a slight increase of intraspecific variation, especially in the female genitalia, could be recognized in specimens from Papua New Guinea that might indicate genetic introgression.

Large regions are colonized by only a single *Tarophagus* species. In the North Pacific, ranging from Taiwan, Belau, Guam, over Micronesia and the Marshall Is to Hawaii, the genus is represented only by *T. colocasiae*. This species has a wide distribution in South-East Asia, extending to Thailand and Malaysia in the west, to Indonesia (Java) in the south

TABLE I. *Distribution of Tarophagus species*

	<i>T. proserpina</i>	<i>T. persephone</i>	<i>T. colocasiae</i>
Thailand			x
Malay Peninsula		x	x
Java (Indonesia)			x
Borneo		x	x
Taiwan			x
Philippines:			
Luzon		x	x
Mindanao			x
Sulawesi (Indonesia)		x	x
Ternate (Indonesia)		x	
Ambon (Indonesia)			x
Papua New Guinea	x	x	x
New Britain		x	x
Solomon Is		x	x
Belona			x
Belau (=Palau)			x
Micronesia:			
Ponape			x
Truk			x
Yap			x
Kusaie†			x
Guam			x
S. Mariana Is†			x
Marshall Is:			
Namorik			x
Kili			x
Hawaii			x
Australia:			
Queensland		x	
Northern Terr.		x	
Vanuatu (=New Hebrides)	x		
New Caledonia	x		
Fiji	x		
Samoa	x		
Tonga†	x		
Cook Is	x		
Niue (Savage Is)	x		
Society Is	x		

† Considered a reliable record from the literature, although the authors have not seen specimens.

Fennah (1978) recorded *T. proserpina* from Vietnam, from where no material was available for the present study. The record concerns either *T. colocasiae* (most likely) or *T. persephone*, and certainly not *T. proserpina*.

and to the Solomon Is in the south-east. In the South Pacific, from Vanuatu and New Caledonia in the west, over Fiji, Samoa, Tonga, the Cook Is to the Society Is (Tahiti), *T. proserpina* occurs exclusively, while in Australia, *T. persephone* is the only *Tarophagus* species found so far.

The closely related species *T. proserpina* and *T. colocasiae* seem to replace each other geographically except in Papua New Guinea. Surprisingly, *T. proserpina* could not be found in samples from the Solomon Is.

Biology and pest status

Earlier studies on the biology and pest status of *Tarophagus* species were all published under the name *T. proserpina*. As a result of the present research, these earlier studies would appear to report the biology of different species depending on the area of study. The position is summarized in Table II. In some cases where two *Tarophagus* species occur in the same country, it is not possible to be certain which species had originally been investigated.

Waterhouse & Norris (1987) includes a table (p. 31) summarizing the attempts to control '*T. proserpina*' in various countries in the Pacific, using both the mirid egg predator *Cyrtorhinus fulvus* Knight and hymenopteran egg parasitoids. In most cases, transfers of *C. fulvus* were successful at controlling the planthopper, but in a few cases they appear not to have been successful. To examine whether this was due to there being different *Tarophagus* species involved, the records of *C. fulvus* have been analysed. The results are far from clearcut (Table III). In some cases, such as transfers between Hawaii and Guam,

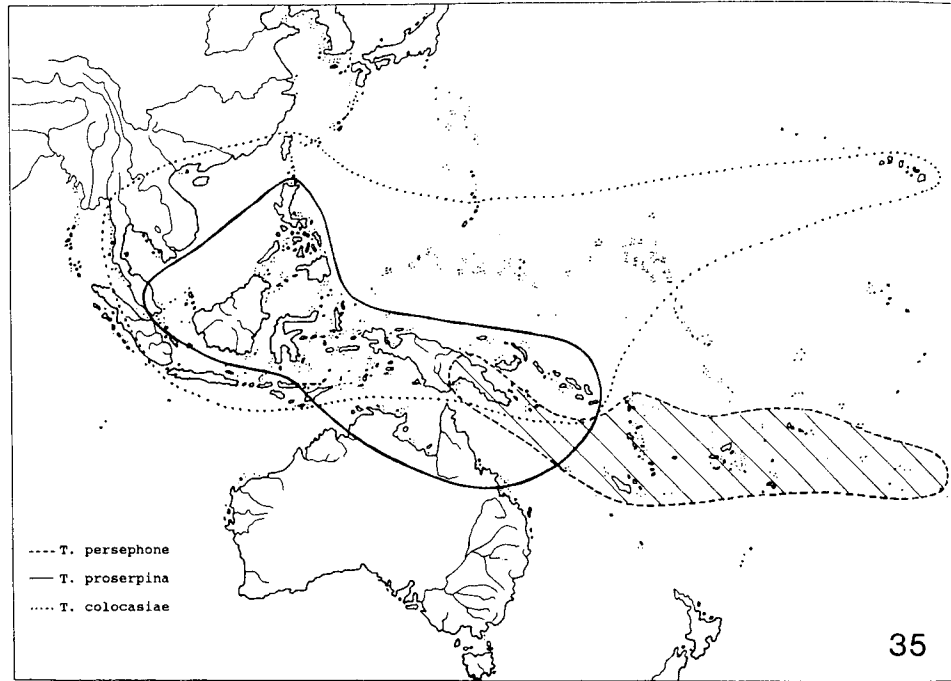


Fig. 35.—Distribution map of *Tarophagus* species.

TABLE II. *Studies of the biology and pest status of 'T. proserpina' with the probable Tarophagus species involved*

Area	Probable species of <i>Tarophagus</i>	Reference
Philippines	<i>persephone</i> or <i>colocasiae</i>	Fullaway (1937) Zimmermann (1948) (repeats Fullaway (1937))
Hawaii	<i>colocasiae</i>	Matsumoto & Nishida (1966) Fullaway (1940)
Solomon Is	<i>persephone</i> or <i>colocasiae</i>	Gollifer <i>et al.</i> (1978) Jackson (1974)
Fiji	<i>proserpina</i>	Hopkins (1927) Swaine (1971)
Samoa	<i>proserpina</i>	Dale (1959)

TABLE III. *Introductions of *Cyrtorhinus fulvus* (Miridae) for the biological control of *Tarophagus* spp. based on Table 4.1 of Waterhouse & Norris (1987)*

To	<i>Tarophagus</i> sp.	From	<i>Tarophagus</i> sp.	Result
Tahiti	<i>proserpina</i>	Hawaii	<i>colocasiae</i>	-
Guam	<i>colocasiae</i>	Hawaii	<i>colocasiae</i>	+
Hawaii	<i>colocasiae</i>	Philippines	<i>colocasiae</i> or <i>persephone</i>	+
Ponape (Caroline Is)	<i>colocasiae</i>	Guam	<i>colocasiae</i>	+
Western Samoa	<i>proserpina</i>	Hawaii	<i>colocasiae</i>	+
Solomon Is	<i>persephone</i> or <i>colocasiae</i>	Sikaiana	<i>persephone</i> or <i>colocasiae</i>	+
		Samoa	<i>colocasiae</i>	-
Tuvalu	<i>proserpina</i>	Fiji	<i>proserpina</i>	-

and between Guam and Ponape in the Caroline Is, *T. colocasiae* is likely to have been the host in both localities.

There may be as much variation in *C. fulvus* as in *Tarophagus* species to account for the variation in success in biological control.

Acknowledgements

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