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Pócs, T. 1992: Correlation between the tropical African and Asian bryofloras. II. — In: Koponen, T. & Hyvönen, J. (eds.), Proceedings of the Congress of East Asiatic Bryology, Helsinki, August 12–19, 1990. — Bryobrothera 1:35–47. Helsinki. ISSN 1235-3949, ISBN 951-96475-0-3

The first account on the Afro-Asian bryogeographic affinities (Pócs 1976) reported 35 liverworts and 73 mosses being bicontinental with this type of disjunction. Intensive field work on both continents and the revision of certain tropical liverwort and moss taxa (e.g. *Ptychanthoideae*, *Sphagnum* L., *Calymperaceae*) revealed such new data on Palaeotropical species, as the African discovery of *Calycularia crispula* Mitt. and *Papillaria flexicaulis* (Wils.) Jaeg. These new investigations raised the number of Afro-Asian bicontinental liverworts to 70 and that of the mosses to 108. Affinities on the generic level are also important. There are Afro-Asian genera with vicariant species, such as *Otolejeunea* Grolle & Tix. in Tix. There are Asian species groups with African representatives such as an undescribed species of *Plagiochila* (Dum.) Dum., section *Abietinae*. On the other hand, several species previously considered Palaeotropical, have been found in the Neotropics or synonymized with Neotropical species. Examples of such changed distributions include: *Diplasiolejeunea incurvata* S. Jov.-Ast. & P. Tix. which is synonymous to *D. cobrensis* Gott. ex Steph. or *Syrrophodon gardneri* (Hook.) Schwaegr. was known from America, as *S. quintasii* Broth.

Key words: Africa, Asia, bryophyta, disjunction, phytogeography.

Tamás Pócs, Eszterházy Károly Tanárképző Főiskola, Növénytani Tanszék, Botanical Department of the Teacher's College, H-3301 Eger Pf. 43, Hungary

Correlation between the tropical African and Asian bryofloras. II

TAMÁS PÓCS

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INTRODUCTION

In the first account on the relationships between the bryofloras of tropical and subtropical Africa and Asia 108 bicontinental disjunct species are reported (Pócs 1976). Since then intensive fieldwork has been accomplished (Pócs 1990), important checklists published (Schultze-Motel 1975, Crosby et al. 1983, Kis 1985), large taxonomic groups monographed (e.g. Frahm 1985, Tixier 1985), and important local floras became available (Jones & Harrington 1983, Magill 1981, 1987). As a result, many more Afro-Asian bicontinental species became known, and, even after deduction of 2 hepatics and 2 mosses, which proved to be Pantropical, the number of Afro-Asian disjuncts is now raised to 178 (70 liverworts and 108 mosses). In the following these species are listed and their distribution pattern discussed.

THE AFRO-ASIAN BICONTINENTAL BRYOPHYTES

During the past few years quite a number of studies appeared dealing with bicontinental and other disjunctions among bryophytes (Buck 1990, Buck & Griffin 1984, Egunyomi 1984, Frahm 1982, Gradstein & Pócs 1989, Gradstein et al. 1983, Grolle 1978, Ochi 1982, Pócs 1988, Redfearn 1990, Reese 1985, 1987, Schuster 1983), but only a few of them treats Afro-Asian distribution patterns. Van Zanten (1978, 1984) discusses the feasibility of intercontinental dispersal of bryophytes.

In Table 1 I try to summarize the species which became known as tropical or subtropical Afro-Asian bicontinental (Palaeotropic) elements since the publication of the first paper of this kind (Pócs 1976).

There are several changes since the publication of

Species	Africa	Asia
Hepaticae		
<i>Bazzania decrescens</i> (Lehm. & Lindenb.) Trev.	+	A
<i>Calycularia crispula</i> Mitt.	E	H
<i>Cephaloziella kiaeritii</i> (Aust.) Douin	E	O
<i>Cheilolejeunea decursiva</i> (Sande Lac.) Schust.	+	+
<i>Cheilolejeunea intertexta</i> (Lindenb.) Steph.	W	O
<i>Cheilolejeunea serpentina</i> (Mitt.) Mizut.	+	O
<i>Cololejeunea bichiana</i> P.Tix.	M	E
<i>Cololejeunea bolombensis</i> (Steph.) Vand. Bergh.	+	+
<i>Cololejeunea cuneata</i> (Lehm. & Lindenb.) Herz.	M	O
<i>Cololejeunea falcata</i> (Horik.) Ben.	M	O
<i>Cololejeunea haskartiiana</i> (Lehm. & Lindenb.) Schiffn.	M	+
<i>Cololejeunea hillebrandii</i> (Aust.) Steph.	+	O
<i>Cololejeunea inflectens</i> (Mitt.) Bened.	Sey	+
<i>Cololejeunea peponiformis</i> Mizut.	M	+
<i>Cololejeunea peraffinis</i> var. <i>elegans</i> Ben.	+	+
<i>Cololejeunea punctata</i> (E.W.Jones) Schust.	+	+
<i>Cololejeunea raduliloba</i> Steph.	+	E
<i>Cololejeunea selangorensis</i> P.Tix.	M	+
<i>Colura pluridentata</i> S.Jov.-Ast	Sey	+
<i>Drepanolejeunea ternatensis</i> (Gott.) Schiffn.	Sey	O
<i>Fossombronina indica</i> Steph.	W	G
<i>Frullania repandistipula</i> Sande Lac.	M	+
<i>Harpalejeunea filicuspis</i> (Steph.) Mizut.	Sey	+
<i>Lejeunea alata</i> Gott.	E	O
<i>Lejeunea cucullata</i> (Reinw. & al.) Nees	Sey	+
<i>Lejeunea tuberculosa</i> Steph.	+	H
<i>Lopholejeunea nigricans</i> (Lindenb.) Schiffn.	Sey	+
<i>Plagiochasma appendiculatum</i> Lehm. & Lindenb.	E	+
<i>Plagiochasma microcephalum</i> (Steph.) Steph.	E	G
<i>Pycnolejeunea multiflora</i> (Steph.) Steph.	Sey	+
<i>Pycnolejeunea nicobarica</i> Steph.	M	G
<i>Radula madagascariensis</i> Gott.	E	+
<i>Radula meyeri</i> Steph. complex incl. <i>R. holstiana</i>	+	+
<i>Schiffneriolejeunea tumida</i> (Nees) Gradst.	Sey	+
<i>Schistochila alata</i> (Lehm.) Steph.	S	+
<i>Spruceanthus marianus</i> (Gott.) Mizut.	Sey	O
<i>Wiesnerella denudata</i> (Mitt.) Steph.	M	+
Musci		
<i>Acaulon leucochaete</i> Stone	S	A
<i>Aongstroemiopsis julacea</i> (Dozy & Molk.) Fl.	S	H
<i>Archidium microthecum</i> Dix. & P.Varde	S, E	G
<i>Bartramia hampeana</i> C. Müll.	S, E	A
<i>Bryobartramia novae-valesiae</i> (Broth.) Stone & Scott	S	A
<i>Bryum aubertii</i> (Schwaegr.) Brid.	S, E	O
<i>Calymperes cougiense</i> Besch.	M	O
<i>Calymperes dozyanum</i> Mitt.	M	O
<i>Calymperes graeffeanum</i> C. Müll.	Sey	O
<i>Calymperes motleyi</i> Mitt. ex Dozy	Sey	+
<i>Calymperes palisotii</i> Schwaegr. ssp. <i>palisotii</i>	+	G
<i>Calymperes serratum</i> A. Braun	W	O
<i>Calymperes taitense</i> (Sull.) Mitt.	Sey	O
<i>Clastrobryophilum rufoviride</i> (Besch.) Fleisch.	Sey	O
<i>Ditrichum difficile</i> (Duby) Fleisch.	E	A
<i>Ditrichum punctulatum</i> Mitt.	S	A
<i>Eccecidium exiguum</i> (Hook.f. & Wils.) Wils. ex Salm.	S	A
<i>Enthostodon wichurae</i> Fleisch.	E	+
<i>Fissidens atroviridis</i> Besch.	E	+
<i>Gammiella merrillii</i> (Broth.) Tix.	+	+
<i>Garckea comosa</i> (Dozy & Molk.) Wijk & Marg.	E	+
<i>Leucophanes angustifolium</i> Ren. & Card.	+	+

Table 1. Additional bicontinental Afro-Asian species, with the indication of their basic distribution type.

Distribution in Africa:

E = restricted to East Africa

S = restricted to South Africa

W = restricted to West Africa

M = reaching only Madagascar and the Mascarenes in Africa

Sey = reaching only the Seychelles from the east

+

Distribution in Asia-Oceania:

H = Himalayan species

G = Gondwanalandic species (S India, Ceylon, Australasia)

A = Australasian species (Australia, Melanesia, New Zealand)

O = species distributed in the Malayan-Oceanian Archipelago

E = East Asian species

+

(Contmd.)

Table 1. *Contnd.*

Species	Africa	Asia
<i>Leucophanes octoblepharioides</i> Brid.	M	+
<i>Macrocoma tenue</i> (Hook. & Grev.) Vitt	S, E	A
<i>Mitthyridium fasciculatum</i> (Hook. & Grev) Robins	M	O
<i>Orthotrichum firmum</i> Vent.	E	E
<i>Papillaria flexicaulis</i> (Wils.) Jaeg.	E	+
<i>Philonotis falcata</i> (Hook.) Mitt.	S	+
<i>Pinnatella mariei</i> (Besch.) Broth.	E	+
<i>Plagiomnium rhynchophorum</i> (Hook.) Kop. var. <i>reidii</i> (Dix.) Kop.	S, E	+
<i>Pleurodium nervosum</i> (Hook.) Mitt.	S	A
<i>Rhodobryum commersonii</i> (Schwaegr.) Par.	S, E	G
<i>Schizymenium bryoides</i> Harv.	S	A
<i>Sphagnum ceylanicum</i> Mitt. ex Warnst.	E	G
<i>Syrrhopodon armatus</i> Mitt.	+	+
<i>Syrrhopodon involutus</i> Schwaegr.	E	+
<i>Thuidium tamariscellum</i> (C. Müll.) Bosch & Sande Lac.	E	+

the first paper in the distributional data:

Anastrophyllum auritum (Lehm.) Steph. became known from Latin America, then its distribution is Panropical (cf. Vána 1982).

Cololejeunea himalayensis (Pande & Misra) Chen et Wu became the synonym of *C. latilobula* (Herz.) P.Tix. (known also under the name of *C. aoshimensis* (Horik.) Mizut.) and its distribution is Indomalayan-Oceanian (cf. Tixier 1985: 157).

Diplasiolejeunea incurvata S. Jov.-Ast. & P. Tix. is the synonym of *D. cobrensis* Gott. ex Steph., then Panropical in distribution, so it is to be canceled from our list.

Macromitrium fasciculare Mitt. occurs also in mainland Africa (Bizot & Pócs 1983: 23).

Sphagnum reichardtii Hampe ex Warnst. is "apparently endemic to St. Paul Island" (Eddy 1985: 96) therefore is to be cancelled from our list.

Syrrhopodon gardneri (Hook.) Schwaegr. proved to be the earlier synonym of *S. quintasii*, therefore Panropical (Orbán & Reese 1986).

VICARIANT PAIRS

Pairs of closely related, vicariant species occurring in the two continents should be mentioned, as their separation is probably the result of the dissection and dislocation of the ancient land masses followed by isolation of the evolved taxa. There is an undescribed, well isolated *Radula* species in Madagascar (Réserve naturelle de Marojezy, 1 350 m) which is, according to Jones (1977: 468), "allied to a group of Indonesian and Polynesian species including *R. cordifolia* Mitt. and *R. densifolia*

Castle". Another very interesting representative of an Asian group in Africa is a recently discovered *Plagiochila* species, which obviously belongs to the well defined Section *Abietinae* Schiffn. This beautiful pinnatifid species imitates the characteristic habit of *Ptychanthus striatus* (Lehm. & Lindenb.) Nees and occurs in the mossy and elfin forests of the Nguru Mountains in eastern Tanzania; at 1 800–2 300 m altitude.

Other vicariant species pairs, which need further investigation:

Lopidium subtrichocladon (Broth.) Fleisch. in Africa and *Lopidium trichocladon* (Bosch & Sande Lac.) Fleisch. in Asia.

Stoneobryum mirum (Lewinsky) Norris and Robinson in South Africa (Natal, Cape), while its pair in Australia (Queensland) is: *Stoneobryum bunyaense* Norris & Robinson.

Triquetrella tristicha (C.Müll.) C.Müll. is a South African endemic (Cape, Oranje F.St., Lesotho and Transvaal) while its closely related counterpart, *Triquetrella papillata* (Hook.f. & Wils.) Broth. lives in Australia (Magill 1981: 187).

Leiomela africana Thér. & Nav. and *L. javanica* (Ren. & Card.) Broth. are so closely related that further investigation might prove their identity.

THE AFRO-ASIAN DISTRIBUTION PATTERNS

In the following I try to classify and summarize from both papers the main types of tropical and subtropical

Table 2. The occurrence of tropical Afro-Asian species on the two continents (abbreviations as on Table 1).

	H	G	E	A	O	+	Total
Sey	—	—	—	—	5	8	13
M	1	3	1	—	14	17	36
E	5	5	1	1	8	17	37
E, S	—	2	—	2	1	1	6
S	1	3	—	5	5	5	19
W	—	1	—	—	2	2	5
+	10	9	1	1	9	32	62
Total	17	23	3	9	44	82	178

Afro-Asian distribution patterns and to establish their ratio and phytogeographical significance (see Table 2).

As can be seen from Table 2, where the African and Asian distribution types are combined, certain combinations are more common, others more rare or even do not occur. 32 Afro-Asian species are widespread on both continents, but not always at equal level of density. *Cheilolejeunea decursiva*, *C. serpentina*, *Colejeunea bolombensis*, *Leucophanes angustifolium* and others are common in the equatorial belt of both continents (see Figs. 1, 2, 5 and 3). Others, like *Cheilolejeunea decursiva*, *Lejeunea tuberculosa* or *Gammiella merrillii* are more rare on both continents (Figs. 1, 4 and 2).

The depth of the penetration of Asian-Oceanian species in Africa is quite different. 13 species reach only the Seychelles from the east (e.g. *Spruceanthus marianus*, *Calymperes graeffeanum*, see Fig. 6). It is remarkable that all of them are very widespread in Asia and they occur in Oceania. Their occurrence in the Seychelles might be the result of long range dispersal, although the age of these islands is very old.

Those 34 species, which reach from the east also Madagascar and the Mascarene islands, but do not occur in mainland Africa, are a bit more inconsistent in their total distribution, as for example *Cololejeunea bichiana* is East Asian (Indochinese), *Wiesnerella denudata* is widespread Himalayan–Southeast Asian or *Frullania repandistipula* Malayan species (see Figs. 7 and 8), but the majority is widespread in Asia–Oceania.

Those elements, which occur in East Africa (37 species) but not further inside the continent, are really variable concerning their Asian distribution (see Figs. 9–12). The 5 Himalayan species (e.g. *Cryptoleptodon*

flexuosus) or the 5 Gondwanalandic species (as *Sphagnum ceylanicum* and *Jaegerina stolonifera*) might indicate old land connections and step by step dispersal. *Ditrichum difficile* is Australasian and *Orthotrichum firmum* East Asiatic. The rest (25 species) are widespread in Asia or partly in Oceania.

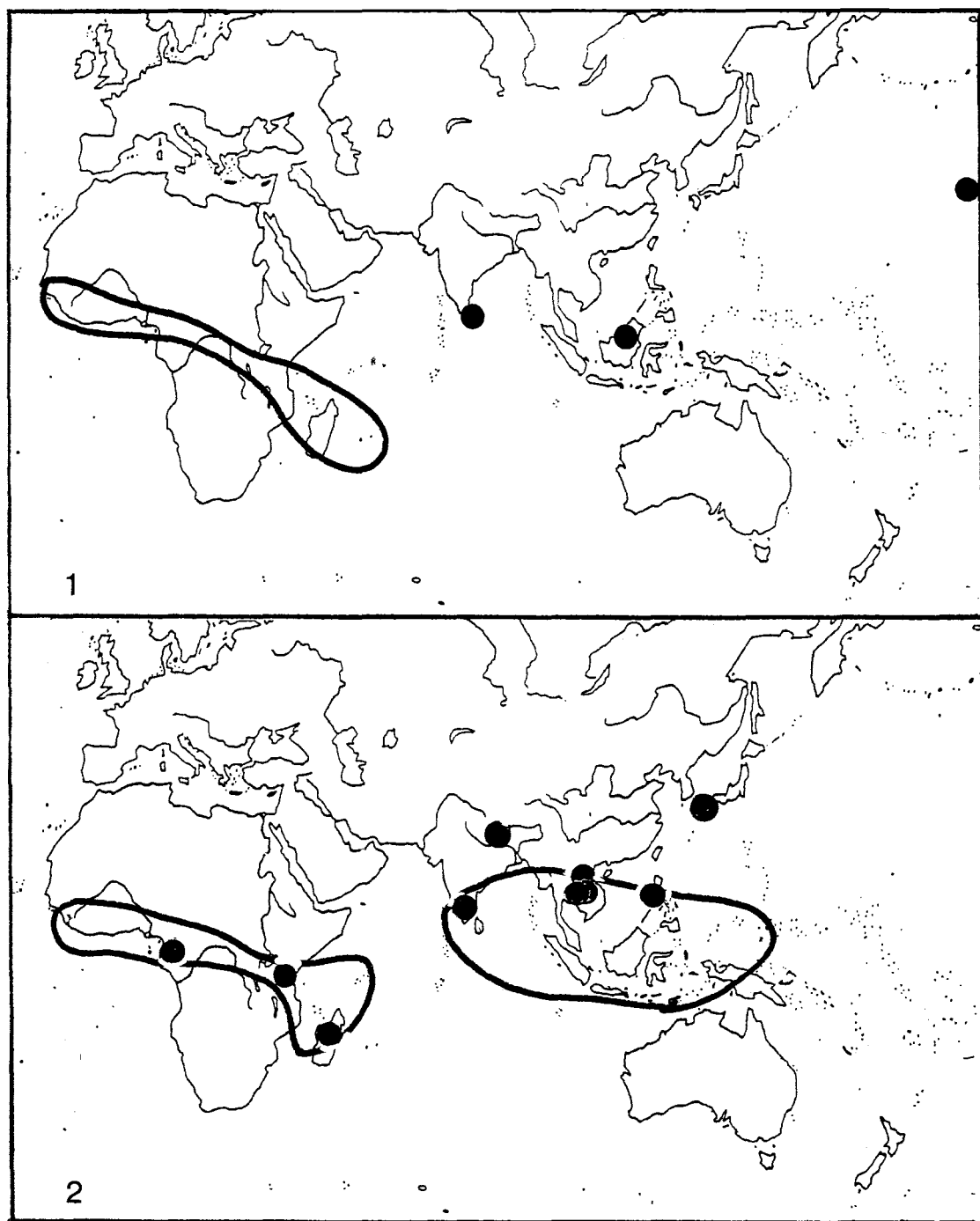
There are two interesting types of disjunction: 5 species in South Africa (*Acaulon leucochaete*, *Ditrichum punctulatum*, *Eccremidium exiguum*, *Pleuridium nervosum* and *Schizymenium bryoides*) are Australasian (see Fig. 13), although the last one is more widespread in southern temperate areas. One Indian and three relatively widespread Asian species occur only in West Africa (*Fossombronina indica*, *Macromitrium seemannii*, *Hypopterygium tenellum* and *Cheilolejeunea intertexta*, see Fig. 14).

CONCLUSIONS

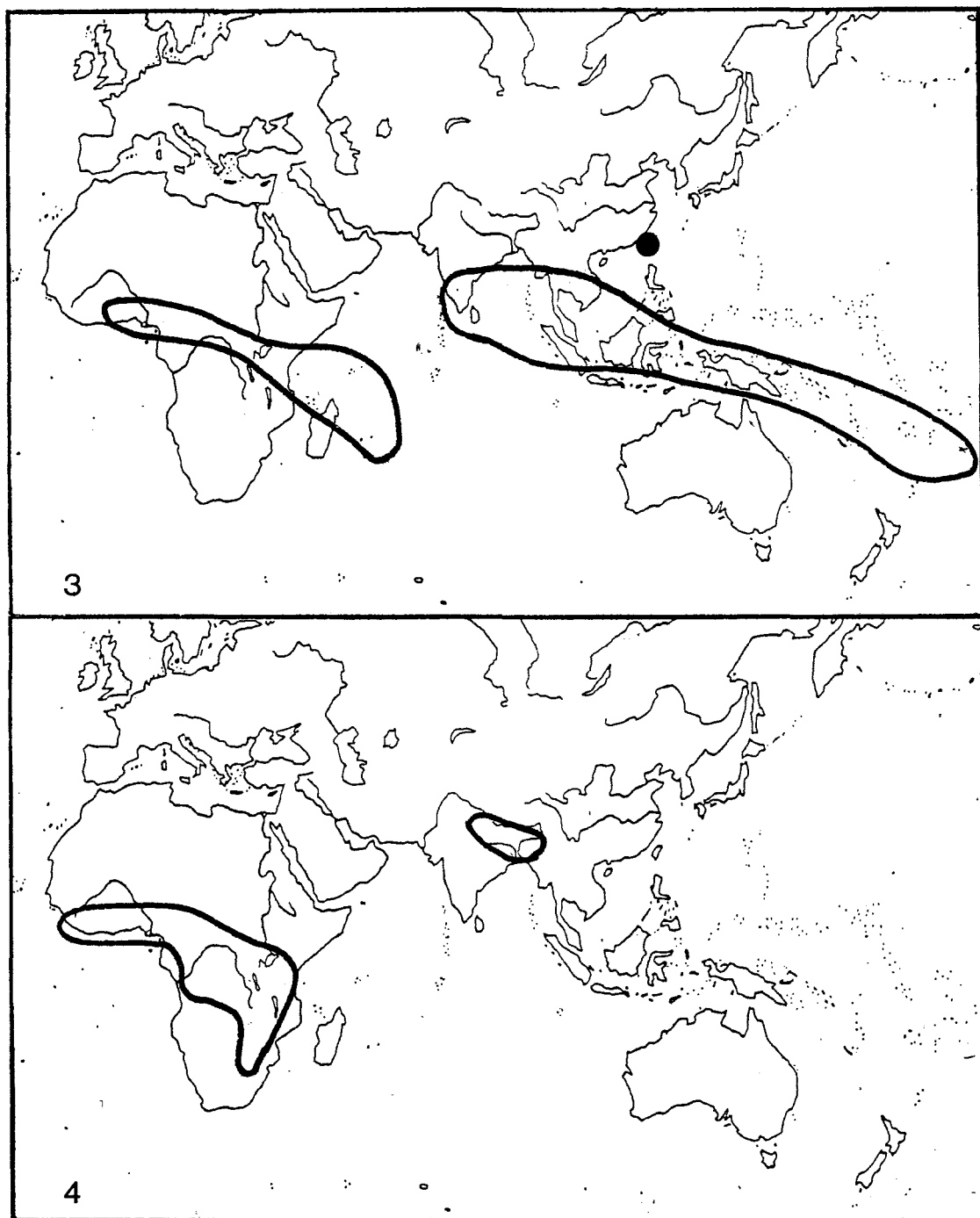
The above analysis of the tropical and subtropical Afro-Asian disjuncts might reveal some clues on the history of African bryoflora. As we are already in possession of data on Afro-American hepatic disjunction (Gradstein et al. 1983), we can conclude that the affinity of hepatic floras at the species level is stronger between Africa and Asia (70 species) than between Africa and the Americas (52 species) although our knowledge is still far from complete.

It is interesting to compare the present data with records of certain areas of America and Asia, where phytogeographic analyses were recently made (e.g. Bryoideae of Australasia, Ochi 1982; bryophytes of Cuba, Pócs 1988; mosses of the Greater Antilles, Buck 1990; mosses of the tropical regions in China, Redfearn 1990). Although more records are needed, it can be provisionally concluded, that at the specific level the tropical Afro-Asian links are stronger than the tropical Afro-American ones and the weakest link in the tropics is between Asia and America. The above facts seem to confirm the concept of "Palaeotropics". The explanation for these peculiarities can be both the different age of the dissection of Gondwanaland parts (possibility of land dispersal) and the different distance between the extant continents (available for long range dispersal).

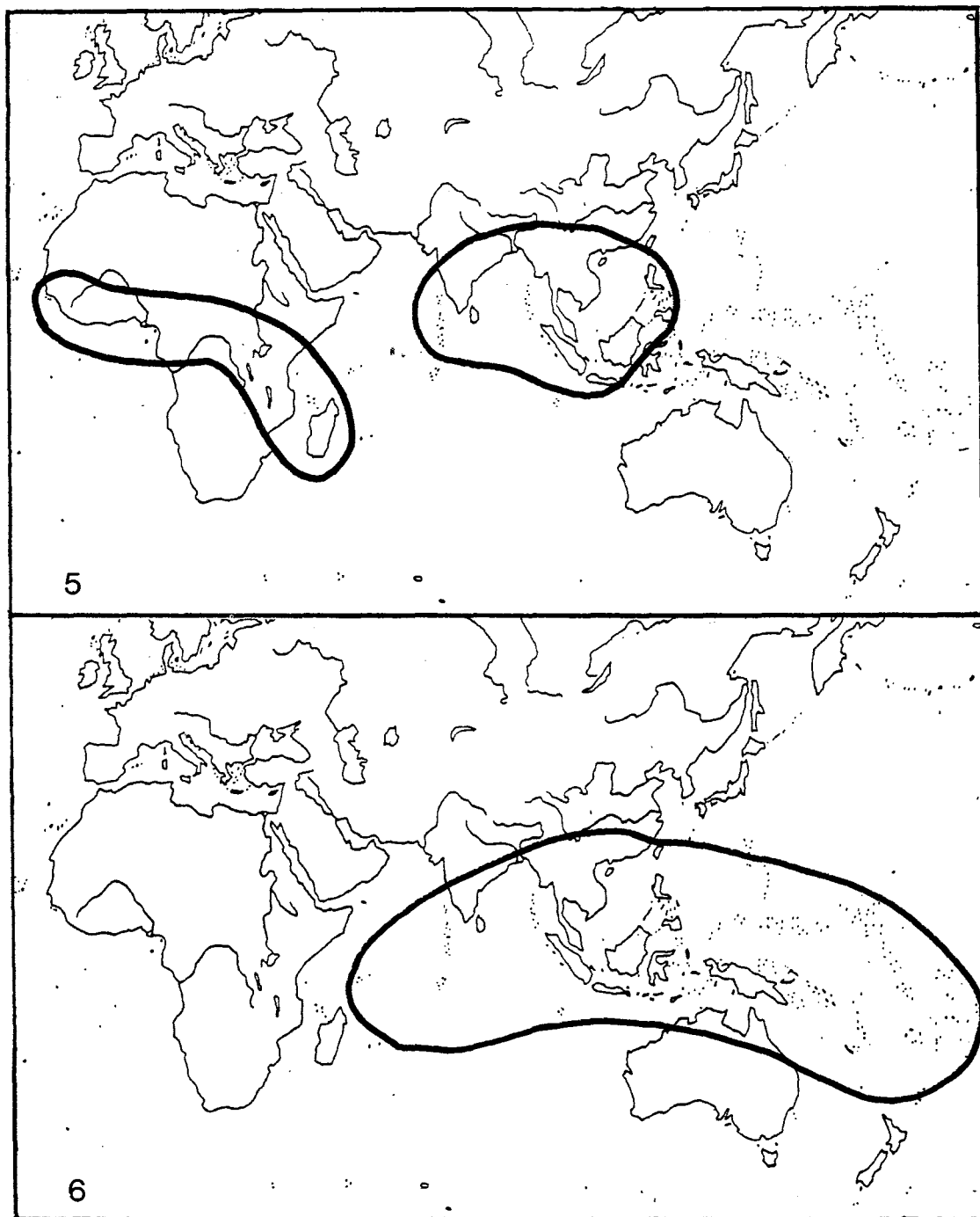
It is interesting that the geographical affinities vary from family to family in connection to the evolutionary history or ecology of the concerned group. Even within a subfamily the different genera can behave differently. Within the Meteoriaceae, the genera *Pilotrichella* (C. Müll.) Besch. and *Squamidium* (C. Müll.) Broth. show strong Afro-American affinity, while *Floribundaria* Fleisch. and *Papillaria* (C. Müll.) C. Müll. species form an obvious Afro-Asian link.



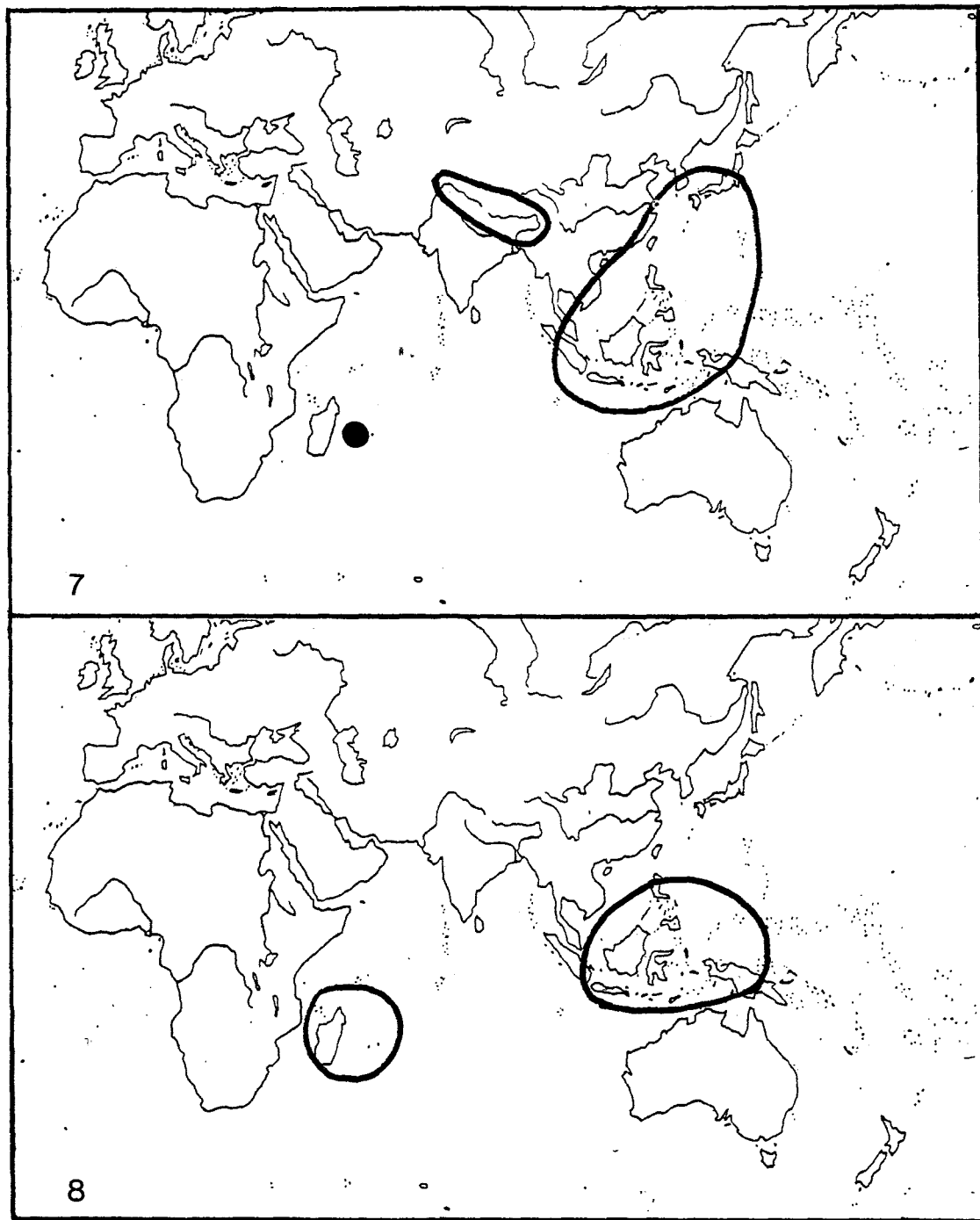
Figs. 1, 2. — 1. *Cheilolejeunea decursiva* (Sande Lac.) Schust. — 2. Solid line: *Cheilolejeunea serpentina* (Mitt.) Mizut. Dots: *Gammiella merrillii* (Broth.) Tix.



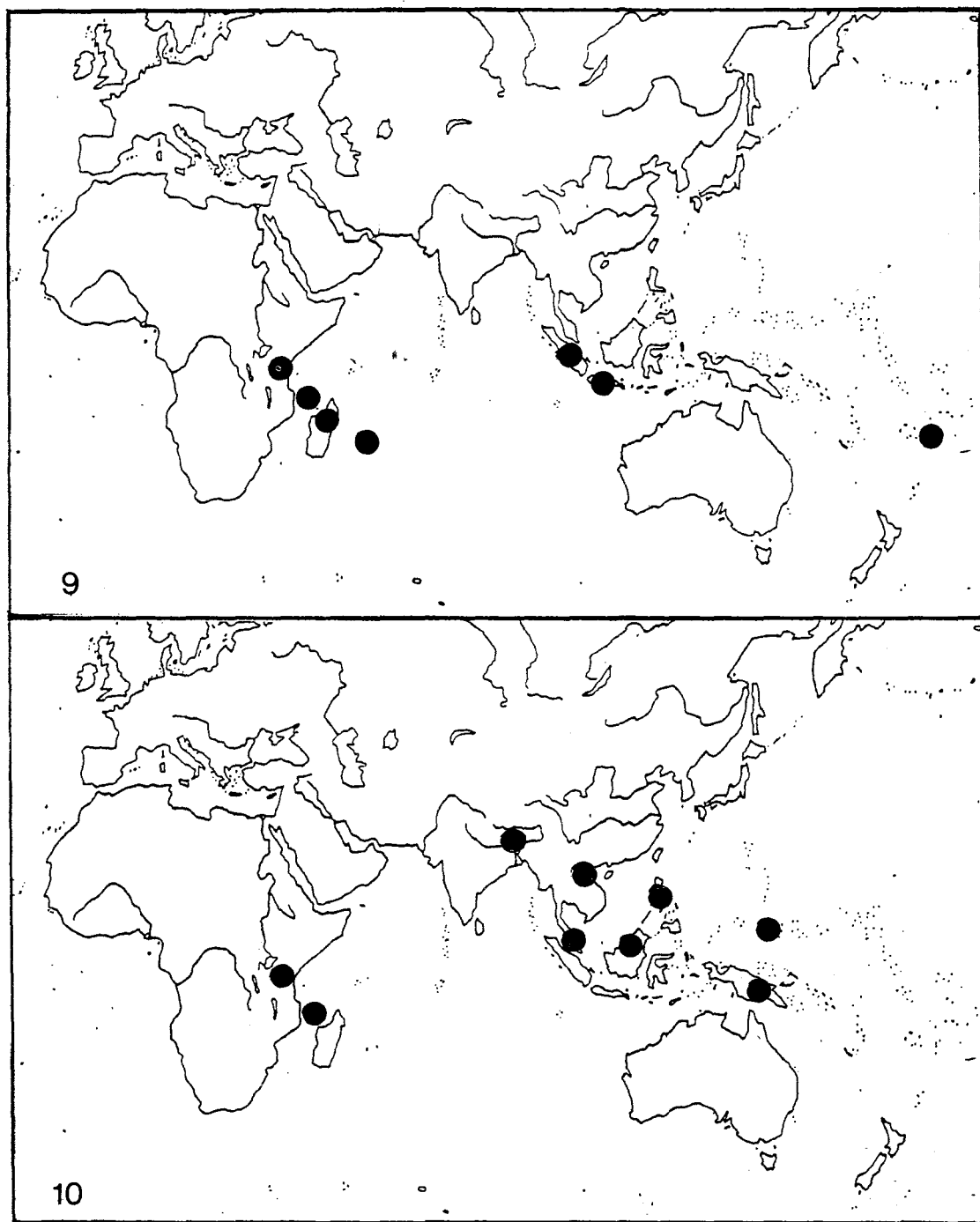
Figs. 3, 4. — 3. *Leucophanes angustifolium* Ren. & Card. — 4. *Lejeunea tuberculosa* Steph.



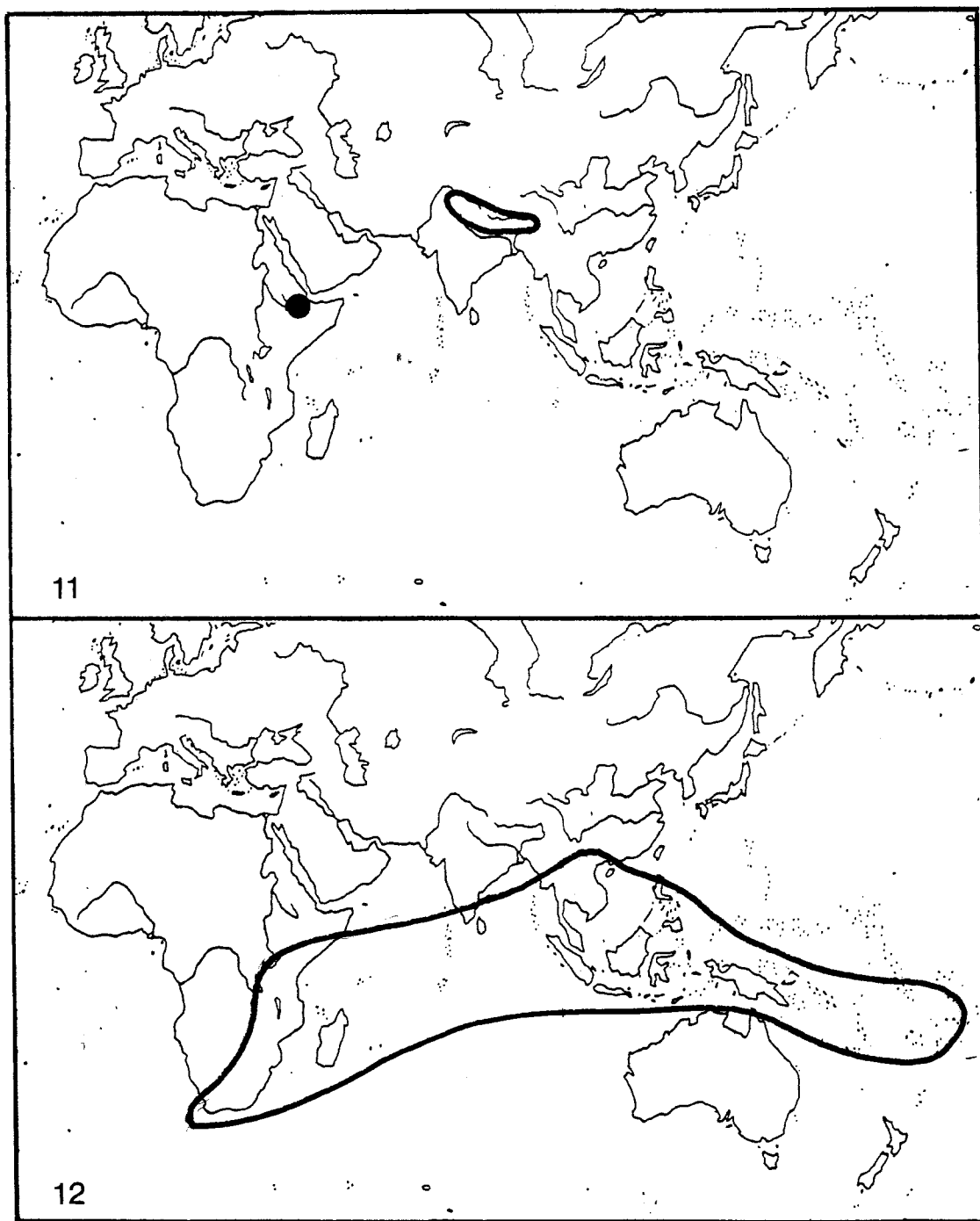
Figs. 5, 6. — 5. *Cololejeunea bolombensis* (Steph.) Vand. Bergh. — 6. *Calymperes graeffeanum* C. Müll.



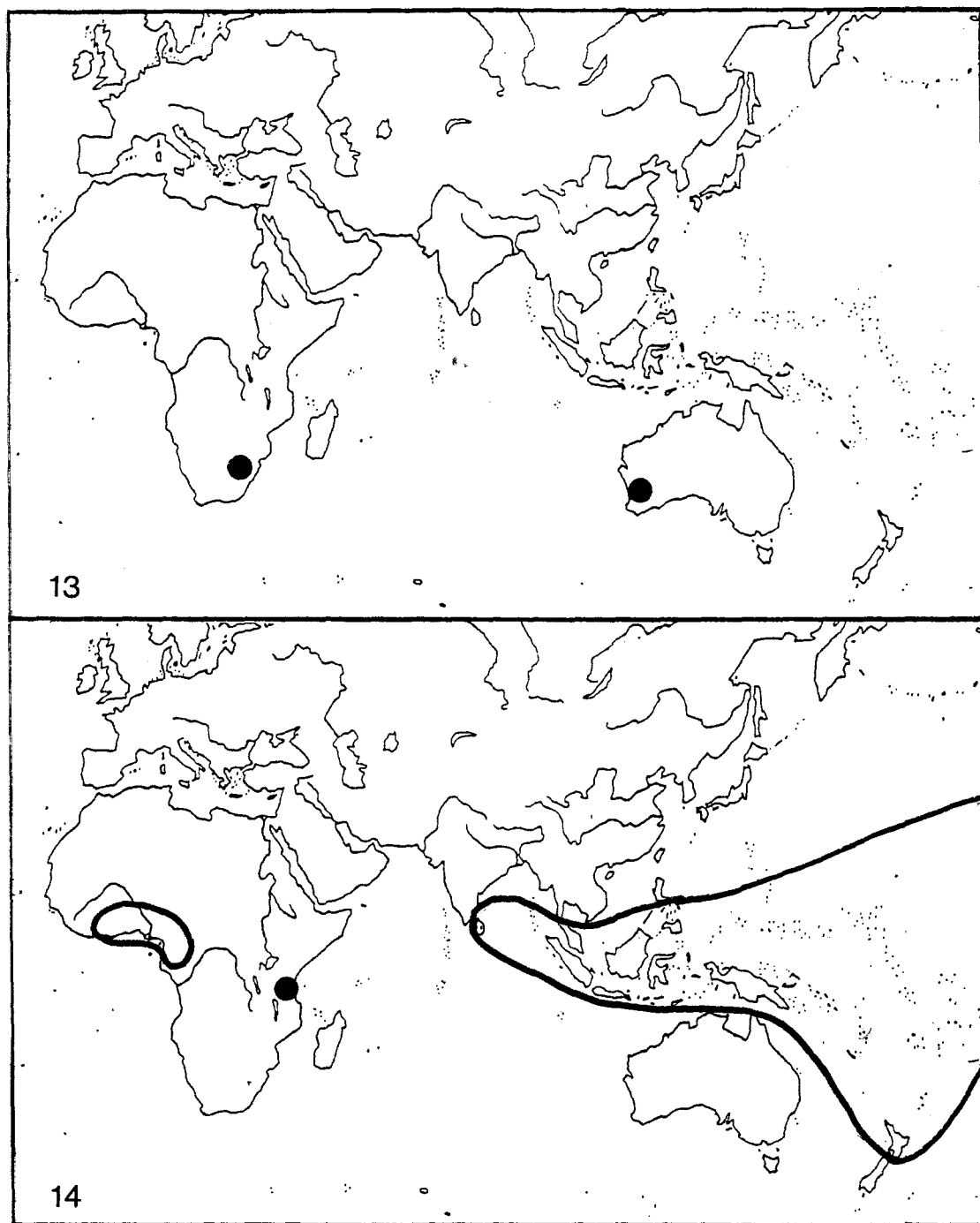
Figs. 7, 8. — 7. *Wiesnerella denudata* (Mitt.) Steph. — 8. *Frullania repandistipula* Sande Lac.



Figs. 9, 10. — 9. *Lejeunea alata* Gott. — 10. *Pinnatella mariei* (Besch.) Besch.



Figs. 11, 12. — 11. *Cryptoleptodon flexuosus* (Harv.) Ren. & Card. — 12. *Cephaloziella kiaerii* (Aust.) Douin.



Figs. 13, 14. — 13. *Ecclremidium exiguum* (Hook.f. & Wils.) Wilms. ex Salm. — 14. *Cheilolejeunea intertexta* (Lindenb.) Steph.

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