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SALTICIDAE (ARACHNIDA: ARANEAE) OF THE KRAKATAU ISLANDS (INDONESIA) – A PRELIMINARY APPROACH

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Abstract

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The salticid fauna of the Krakatau Islands is investigated in respect to species composition, immigration, colonisation-extinction rates and relationships with adjacent areas. The changes in fauna of Panjang between 1931 and 1991 are discussed and the salticids of other islands of the archipelago are studied. Of 33 species known from the area in 1984-91, 22 are listed from Anak Krakatau, 19 from Rakata, 14 from Panjang and 12 from Sertung.

Introduction

The island life has been the subject of research for over a century and has resulted in hundreds of biogeographical papers, the synthesis by MACARTHUR AND WILSON (1967) and CARLQUIST (1965, 1974) being the best known. Of all the islands, Hawaii and Galapagos have traditionally been the most intensely investigated (e.g., WAGNER, FUNK, 1995; KEAST, MILLER, 1995).

Since the gigantic eruption in 1883 and complete elimination of biota, the Krakatau Islands have also become a unique research laboratory (DAMMERMAN, 1948; THORNTON, NEW, 1988; THORNTON et al., 1990; BUSH, WHITTAKER, 1991). MACARTHUR AND WILSON (1963, 1967) tested their equilibrium model there – mostly for bird fauna and flora, but also other groups of colonisers (e.g., arthropods, nematodes, molluscs, plants) were intensely studied (SMITH, DJADJASASMITA, 1988; THORNTON, NEW, 1988; THORNTON et al., 1988; WHITTAKER et al., 1989; THORNTON, 1995 a, b). The research even intensified with the appearance of a new volcano, Anak Krakatau, in 1930 and with its subsequent eruptions (THORNTON, WALSH, 1992; THORNTON et al., 1992).

According to most authors (e.g. THORNTON, NEW, 1988; WHITTAKER et al., 1989; BUSH, WHITTAKER, 1991) there are at least four good reasons for the Krakatau Islands to be an excellent example of primary colonisation in the tropics: (1) a known starting point of colonisation; (2) little human influence; (3) well defined sources of colonisation (Sumatra and Java); (4) well documented biological history.

The present paper is one of nearly a hundred devoted to different aspects of biogeography of the area and one of very few dealing with spiders. We select jumping spiders (Salticidae) as a good model for zoogeographical considerations. The main objectives of the study are: (1) to analyse salticid dispersal possibilities and colonisation effectiveness, (2) to analyse the salticid species composition for each island and for the whole archipelago, (3) to evaluate changes (turnover) since the first data were collected, (4) to analyse the total distribution of species and their potential source.

Material and methods

The spiders were collected during 5 Krakatau research expeditions led by Prof. I. Thornton (La Trobe University, Victoria, Australia) in 1984, 1985, 1986, 1990 and 1991 (THORNTON, 1985, 1986, 1987; THORNTON, ROSENGREN, 1988).

Altogether 954 salticid specimens representing 33 species from 27 genera were investigated (Table 1, 2). Of course, the real fauna is much richer as the majority of juveniles (640 of 744) were not possible to identify. At least 7 species are new for science which is the result of limited knowledge of the entire Oriental salticid fauna rather than their endemic Krakatau status. The bulk of material (56%) comes from Anak Krakatau.

The specimens were taken by hand from vegetation, tree trunks, logs, stones, rocks and ground, beaten (swept) from vegetation or trapped with Malaise aerial traps and water pitfall-traps (Table 3) (for details see: THORNTON et al., 1988). The habitats sampled represent various successional stages (Table 4).

Although the collecting methods and selection of biota do not fully meet ecological standards – especially for quantitative considerations – we make such an attempt to provide the analysis for each species, island and habitat. Unlike in many zoogeographical papers dealing with the Oriental and Pacific spider faunas, we make our conclusions not for families and genera but, where possible, at the species level – with all the obvious advantages of this approach. The whole Krakatau salticid collection will be the subject for a further taxonomic paper being prepared by one of us (MŻ) and will be deposited in the Naturhistorisches Museum, Bern, Switzerland.

Results and discussion

The area

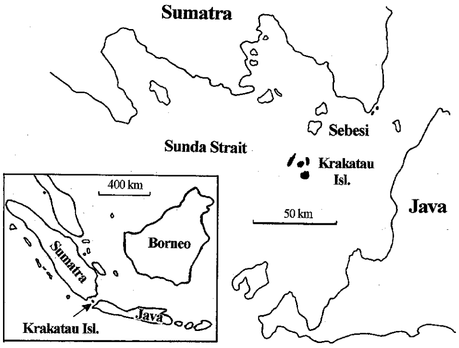
On August 26-27th, 1883 the island-volcano Krakatau erupted in a series of gigantic explosions which destroyed two-thirds of the island, generated tsunami that killed some 36 000 people populating the Sunda Strait area, and ejected 18-21 km^3 of pyroclastics that covered the island itself and adjacent Sertung and Panjang with a tens of meters-deep layer of ash and pumice. Today the Krakatau archipelago consists of four islands: Rakata, Panjang, Sertung and Anak Krakatau, the first being the remnant of the ancient pre-1883 volcano and the latter emerging from post-1883 caldera in August 1930.

T a b l e 1. Salticidae of the Krakatau Islands – material studied (1984-91).

	Rakata	Sertung	Panjang	Anak Krakatau	Not specified	Σ
♂	23	10	6	48	4	91
♀	33	21	9	48	8	119
Juv.	67	131	58	443	45	744
Σ	123	162	73	539	57	954

T a b l e 2. Salticidae of the Krakatau Islands collected in 1984-91.

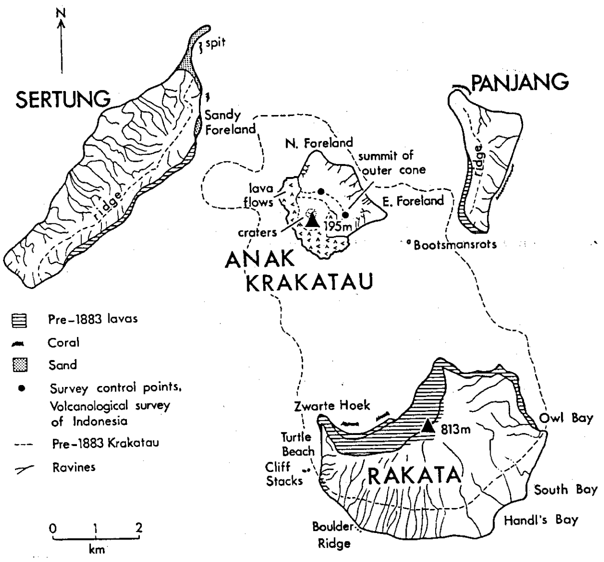
Species	**Rakata**	**Sertung**	**Panjang**	**Anak Kr.**
Artabrus erythrocephalus (C. L. K.)	+	+	+	+
Cosmophasis sp. 1.	+	+	+	+
Plexippus paykulli (SAV. et AUD.)	+	+	+	+
Pseudicius sp. n.	+	+	+	+
Myrmarachne sp.	+	+	+	+
Zenodorus sp. 2.	+	+	+	+
Hasarius adansoni (SAV. et AUD.)	+		+	+
Phintella debilis (TH.)	+	+	+	
Siler semiglaucus (SIMON)	+		+	+
Carrhotus sannio(TH.)			+	+
Cosmophasis sp. 2.	+			+
Evarcha pococki ŻABKA	+			+
Evarcha sp. n.			+	+
Marengo sp. n.	+		+	
Portia labiata (TH.)	+	+		
Rhene albigera (C. L. K.)		+		+
Thiania bhamoensis TH.	+			+
Zenodorus sp. 1.	+	+		
Afraflacilla sp. n.				+
Bristowia heterospinosa REIM.				+
Chrysilla sp.		+		
Cocalodes sp. n.				+
Cosmophasis sp. 3.	+			
Cosmophasis sp. 4.	+			
Cytaea sp.		+		
Hyllus diardi (WALC.)	+			
Langona bhutanica PROS.				+
Menemerus bivittatus (DUF.)				+
Neon sp. n.			+	
Neon sumatranus LOGUNOV	+			
Phlegra sp. n.				+
Telamonia sp.			+	+
Thyene sp.				+
Number of species	**19**	**12**	**14**	**22**



Map 1. Sunda strait showing the Krakatau Islands, after Thorton (1987).

T a b l e 3. Salticids collected by different methods.

Collecting method	No. of specimens
Beating (sweeping)	597
Pitfall trapping	140
Hand	50
Malaise aerial traps	17
Not specified	150
Total	**954**



Map 2. Krakatau Islands in 1985, after Thorton (1987).

The question of whether or not any of the Krakatau Islands biota could have survived the volcanic events of 1883 has been discussed by many authors (e.g. THORNTON, ROSENGREN, 1988; THORNTON, NEW, 1988). It seems that, at least for spiders, the area has been sterilised and today's fauna consists of new colonisers only. In fact, the starting point of the colonisation in 1883 is not so obvious because, from the very beginning in 1930, Anak Krakatau has been very active, erupting many times (e.g. 1952, 1953, 1972, 1988, 1992, 1993) and affecting also other islands, especially Panjang and Sertung. Some authors claim that the 1952 events were sterilising – at least for Anak Krakatau (THORNTON et al., 1994).

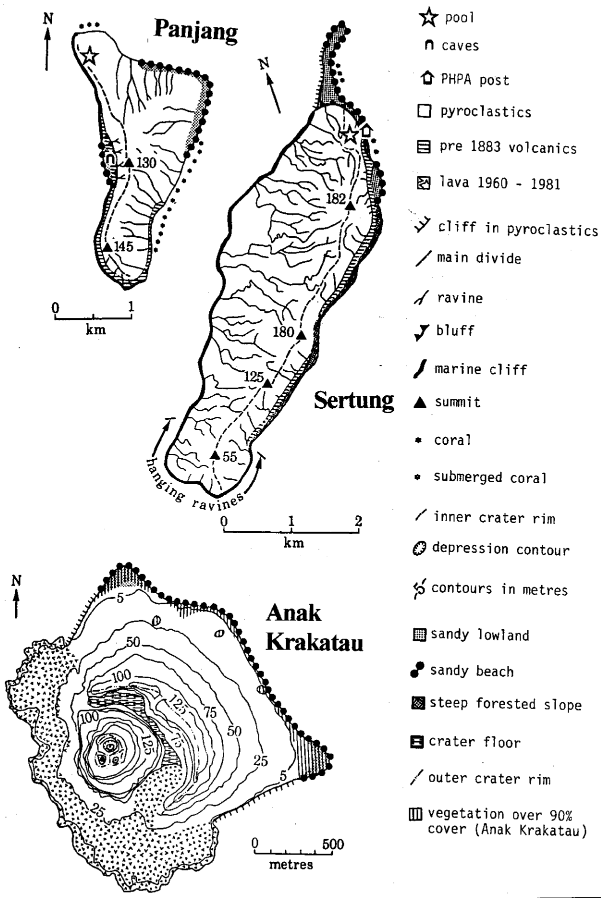
The Krakatau Islands are situated in the Sunda Strait, some 40 km away from Sumatra and Java (Maps 1, 2, 3). The islands differ in size, shape, topography and floristic formations, the parameters influencing the immigration ratio.

Rakata is the largest (11.5 km^2) and highest (above 800 m). It is steep with a deep radial gully system bounded by steep eroding cliffs. The vegetation is the most diverse (some 260 species: WHITTAKER et al., 1989) and constitutes various communities, depending mostly on altitude and soil: from pioneer shore vegetation (*Barringtonia asiatica*, *Calophyllum inophyllum*, *Ipomoea pres-caprae*, *Pandanus tectorius*, *Spinifex littoreus*), grasslands (*Saccharum spontaneum*, *Imperata cylindrica*), single *Casuarina* trees, *Casuarina* forest (*C. equisetifolia*) – to secondary rainforest with dominating *Neonauclea calycina* and various species of *Ficus*.

Sertung is the second largest of the group (7.9 km^2, 182 m high, 8 km long, 2 km at its widest point). After the 1883 eruption the island increased three times as the result of the accumulation of a 70 m thick pyroclastics layer. The western surface is now dissected by deep gullies while the eastern part forms a deep forested coastal slope. Beaches are covered with *Ipomoea pes-caprae* association. The main body is covered in tropical monsoon

T a b l e 4. Number of specimens in particular habitats (1984-91).

Rainforest	267
Casuarina forest	174
Grassland	164
Shore	39
Barren sand	20
Camp area	9
Tree trunks	6
Barren lava	5
No data	270
Total	**954**



Map 3. Anak Krakatau, Panjang and Sertung: topography and habitats, after Thorton (1987).

rainforest with *Timonius* and *Dyosoxylum* trees.

Panjang (2.7 km^2, 140 m high, 3 km long, 1.5 km wide) has been the most intensely studied. Over 160 plant species are known there, building mostly *Casuarina-Dyosoxylum* forest and rainforest associations.

Anak Krakatau (2.35 km^2, 195 m high, 2 km in diameter) emerged in 1930 and since then has erupted many times, the 1952 events being probably sterilising. Beach pioneer vegetation is made of *Barringtonia asiatica*, *Ipomoea pes-caprae*, *Pandanus tectorius* association. Grassy vegetation is made of *Spinifex*, *Ipomoea*, *Ischaemum* and *Saccharum* while *Casuarina* and rainforests are as on Rakata.

Human influence

There have been only short periods of time when the Krakatau Islands had permanent inhabitants and their influence has been very little. Between August 1896 and January 1897 a small topographical survey team was operating on Panjang, being supplied from Java twice a month. In 1915-1922 J. Handl and a group of people stayed on Rakata extracting pumice, planting crops and keeping fowl, geese and pigs. In 1919 Rakata was visited by scientists who caused a fire that burned the western, grass-steppe part of the island. In 1928-1931 the Volcanological Service carried out the observations on Panjang. In 1951 a cottage and cultivated garden were established on Sertung, but both were destroyed by the eruption of Anak Krakatau in 1952. Also since 1888 the islands have been visited by scientific expeditions which spent some 500 days there altogether, most of that on Rakata and Anak Krakatau, and tourists have been visiting the area for short periods of time.

Salticidae – a research model

Jumping spiders have a reputation of being a good model-group for zoogeographical analyses: (1) The family itself is well defined, and diverse (about 5000 species described). The taxonomy of the family, especially of some subfamilies (tribes), is relatively well known. (2) The salticids have been studied world-wide and continental (local) faunas are more or less distinguished – also as the result of limited dispersal power (except for a few species). (3) The family is old enough (the oldest fossils come from the Eocene, some 50 MY) to consider the long-term processes, e.g., plate tectonics and isolation influencing the evolution of taxa and faunas.

Salticid dispersal

The dispersal capacities vary, depending on spider size, age, living strategy, habitat, climatic conditions and dispersing agent.

For the analysed case at least four dispersal mechanisms are possible: rafting, ballooning, human agency and slow penetration, the first three being the source of immigrants from outside the archipelago (and between its islands) and the latter being also (first of all?) of importance within particular islands.

Rafting. The beaches of the Krakatau Islands are covered with logs, pumice and human debris. Logs, can transport spiders and their egg-sacs in crevices or under bark. An important source of immigrants may be floating masses of living vegetation that include palms and herbs. During the 1986-expedition a freshly beached mass of 20 m^2 was found (THORNTON, NEW, 1988). In other areas floating vegetation masses were recorded to travel as far as 1800 km (POWERS, 1911). Though there is no data on rafting in spiders, it seems effective – especially for ground and litter dwellers. The majority of collected salticids are either ground or vegetation inhabitants and may well be transported by rafting (Table 8, 9).

Ballooning. Unlike insects or mites, the spider aeroplankton mostly consists of juveniles which, being smaller, find it easier to balloon, but they are difficult/impossible to identify to species. There are a few factors influencing ballooning dispersal, e.g., strength, regularity and direction of wind, biological character of barriers, spider size, biology and physiological adaptations to stress. Various habitats provide different aerial dispersal possibilities. Leaf-litter or bark dwellers, for instance, are poorer candidates for ballooning than are open-area or tree-canopy inhabitants. The effectiveness of ballooning dispersal and the taxonomic composition of aeronauts also differ, depending on the area.

The majority of data for spiders comes from northern temperate areas. Theoretically, ballooning, as a passive mode of transport, should not be as common in the tropics, for at least two reasons: 1. For rainforest dwellers the wind currents are too weak and limited to the highest canopy level, and 2. the majority of species are narrow niche specialists and ballooning for them means „taking a risk" of finding themselves in inappropriate conditions. There are, however, some examples where tropical islands are colonised by ballooning dispersal, such as some islands off Australia (MAIN, 1981; PATOLETA, ŻABKA, 1999).

Salticidae constitute only 1% to 7.5% of spider aeroplankton (HORNER, 1975; SALMON, HORNER, 1977; GREENSTONE et al., 1987, BLANDENIER, FÜRST, 1998) and, as in other families, the juveniles are also more effective ballooners than the adults. In our collection only 17 specimens (7 juveniles) were captured with Malaise aerial traps, including adults of *Myrmarachne* sp., *Plexippus paykulli* and *Siler semiglaucus*. The data seems, however, not representative enough, since aerial trapping has not been applied as intensely as other methods.

Anthropodispersal. This dispersal method is typical for synanthropic species or those having wide ecological requirements. As a result they have wide, sometimes even world wide, distribution. Five such species are known to occur in tropical Asia and three of them, *Hasarius adansoni, Plexippus paykulli* and *Menemerus bivittatus*, are found on the Krakatau Islands. While the latter is limited to human habitations, the first two are also found elsewhere (Table 9). Additionally three other Krakatau species, *Langona bhutanica*, *Siler semiglaucus* and *Cytaea* sp. are also associated with man. The exact dispersal mechanism for all those species is not known.

T a b l e 5. Changes in salticid species composition on Panjang between 1931 and 1984-91, including new species. Gains: 9 species, losses: 13 species.

	Species	1931	1984–1991
1.	*Artabrus erythrocephalus* (C.L.K.)		+
2.	*Bavia sexpunctata* (DOL.)	+	–
3.	*Bristowia heterospinosa* REIM.	+	–
4.	*Carrhotus sannio* (TH.)	+	+
5.	*Cosmophasis laticlavia*	+	–
6.	*Cosmophasis sp. 1.*		+
7.	*Cosmophasis thalassina* (C. L. K.)	+	–
8.	*Cosmophasis viridifasciata*	+	–
9.	*Cytaea guentheri*	+	–
10.	*Evarcha sp. n.*	+	+
11.	*Hasarius adansoni* (AUD.)		+
12.	*Hyllus diardi* (WALC.)	+	–
13.	*Marengo sp. n.*		+
14.	*Menemerus bivittatus* (DUF.)	+	–
15.	*Myrmarachne sp.*	+	+
16.	*Neon sp. n.*		+
17.	*Pancorius sp.*	+	–
18.	*Phintella debilis* (TH.)		+
19.	*Plexippus paykulli* (SAV et AUD.)	+	+
20.	*Portia fimbriata* (DOL.)	+	–
21.	*Pseudicius sp. n.*		+
22.	*Rhene bufo*	+	–
23.	*Rhene rubigera* (TH.)	+	–
24.	*Siler semiglaucus* (SIMON)		+
25.	*Telamonia sp.*	+	+
26.	*Thiania demissa*	+	–
27.	*Zenodorus sp. 2.*		+
	Number of species	**18**	**14**

The island salticids

The research of island spiders began almost 70 years ago (for review see: BAERT, JOQUÉ, 1993; LEHTINEN, 1996; PRÓSZYŃSKI, 1996; GILLESPIE et al., 1998). Of all the papers only few seriously dealt with salticids (BRISTOWE, 1931; BERLAND, 1934; ŻABKA, 1988, 1993; PRÓSZYŃSKI, 1992, 1996; BERRY et al., 1996, 1997, 1998; PATOLETA, ŻABKA, 1999) and even less provided comprehensive zoogeographical data. Some zoogeographical analyses were and still are based on genus or even family level taxonomy, which makes them of limited use as being too general.

Jakobson made the first spider collection for Krakatau Islands in 1908 and listed 28 species altogether, not specifying their taxonomic status. Between 1919 and 1922 Dammerman took 45 species and 50 were taken by J. Baum in 1929. None of the above collections has, however, been worked out and the first two have been lost or ruined, respectively. During his voyage to Panjang (= Lang) in 1931, Bristowe collected 91 spider species, 54 of them studied by Reimoser (1934), including 18 salticids (Table 5).

What fauna inhabited Rakata and Sertung in the 1930s is not known. Taking into account the immigration rate for Anak Krakatau (22 species since 1930, perhaps since 1952) and for Panjang (18 species between 1883-1931) as examples, Rakata must have been even more effectively inhabited at that time and must have also been a source of immigrants for other islands of the archipelago.

As stated before, the rich source faunas of Sumatra and Java create a constant flow of potential colonisers. So far 115 salticid species (of 57 genera) are recorded from Sumatra and 70 species (from 46 genera) are known from Java (PRÓSZYŃSKI, 1999), but considering the islands' size and diversity of life, the numbers surely are highly underestimated. Of 24 known Krakatau island species (excluding new ones and identified to the genus level only) 16 and 9 species are also listed from Sumatra and Java, respectively (Table 7).

Altogether, since 1931, 43 species have been reported from the Krakatau Islands (Table 6) but considering the past and present data, only two islands, Panjang and Anak Krakatau, can be discussed in respect to colonisation-extinction rates and habitat preferences. In the 1930s the salticids of Panjang amounted to 18 species. Only 5 were recorded in the collections of the 1980s and 1990s and can be called „successful colonisers" – especially *Plexippus paykulli,* which is found on every island of the archipelago. During the period of 60 years, 13 species disappeared and 9 new ones colonised the

Table 6. Salticids of the Krakatau Islands (1931 – data for Panjang, 1984-91 – whole archipelago). Gains: 25 species, losses: 10 species.

Species	**1931: 18 sp.**	**1984–1991: 33 sp.**
1. *Afraflacilla sp. n.* (C.L.K.)		+
2. *Artabrus erythrocephalus*		+
3. *Bavia sexpunctata* (DOL.)	+	–
4. *Bristowia heterospinosa* REIM.	+	+
5. *Carrhotus sannio* (TH.)	+	+
6. *Chrysilla sp.*		+
7. *Cocalodes sp. n.*		+
8. *Cosmophasis laticlavia* (TH.)	+	–
9. *Cosmophasis sp. 1*	+	+
10. *Cosmophasis sp. 2*		+
11. *Cosmophasis sp. 3*		+
12. *Cosmophasis sp. 4*		+
13. *Cosmophasis thalassina* (C. L. K.)	+	–
14. *Cosmophasis viridifasciata* (DOL.)	+	–
15. *Cytaea guentheri* TH.	+	–
16. *Cytaea sp.*		+
17. *Evarcha pococki* ŻABKA		+
18. *Evarcha sp.*	+	+
19. *Hasarius adansoni* (SAV et AUD.)		+
20. *Hyllus diardi* (WALC.)		+
21. *Langona bhutanica* PROS.		+
22. *Marengo sp. n.*		+
23. *Menemerus bivittatus* (DUF.)	+	+
24. *Myrmarachne sp.*	+	+
25. *Neon sp. n.*		+
26. *Neon sumatranus* LOGUNOV		+
27. *Pancorius sp.*	+	–
28. *Phintella debilis* (TH.)		+
29. *Phlegra sp. n.*		+
30. *Plexippus paykulli* (SAV et AUD.)	+	+
31. *Portia fimbriata* (DOL.)	+	–
32. *Portia labiata* (TH.)		+
33. *Pseudicius sp. n.*		+
34. *Rhene albigera* (C. L. K.)		+
35. *Rhene bufo* (DOL.)	+	–
36. *Rhene rubigera* (TH.)	+	–
37. *Siler semiglaucus* (SIMON)		+
38. *Telamonia sp.*	+	+
39. *Thiania bhamoensis* TH.		+
40. *Thiania demissa* (TH.)	+	–
41. *Thyene sp.*		+
42. *Zenodorus sp. 1*		+
43. *Zenodorus sp. 2.*		+

T a b l e 7. Distribution of salticid species on the Krakatau Islands (1931-91), excluding new species (C- cosmotropical, IP- Indopapuan, WT- wide tropical).

Species on Krakatau Isl.			Other distribution
1.	*Artabrus erythrocephalus* (C.L.K.)	IP	Sumatra, Java
2.	*Bavia sexpunctata* (DOL.)	WT	Japan, Sumatra, Java, N. Guinea, Australia, Pacific Isl.
3.	*Bristowia heterospinosa* REIM.	WT	China, Korea, Japan, Vietnam
4.	*Carrhotus sannio* (TH.)	WT	India, Sri Lanka, China, Burma, Malaysia, Sulawesi
5.	*Cosmophasis laticlavia* (TH.)	IP	Sumatra
6.	*Cosmophasis thalassina* (C. L. K.)	WT	Malaysia, Sumatra, Java, N. Guinea, Australia
7.	*Cosmophasis viridifasciata* (DOL.)	IP	Sumatra, Java, N. Guinea
8.	*Cytaea guentheri* TH.	IP	Burma
9.	*Evarcha pococki* ŻABKA	WT	China, Bhutan, Vietnam
10.	*Hasarius adansoni* (SAV. et AUD.)	C	Cosmotropical
11.	*Hyllus diardi* (WALC.)	WT	China, Indochina, Malacca, Sumatra, Java
12.	*Langona bhutanica* PROS.	WT	Bhutan, China
13.	*Menemerus bivittatus* (DUF.)	C	Cosmotropical
14.	*Neon sumatranus* LOGUNOV	IP	Malaysia, Sumatra, N. Guinea
15.	*Phintella debilis* (TH.)	WT	India, China, Korea, Vietnam
16.	*Plexippus paykulli* (AUD.)	C	Cosmotropical
17.	*Portia fimbriata* (DOL.)	WT	India, Sri Lanka, Hong Kong, New Guinea, Salomon Isl., Malacca, Australia
18.	*Portia labiata* (TH.)	WT	Sri Lanka, Burma, Sumatra, Java, Philippines, Burma
19.	*Rhene albigera* (C. L. K.)	WT	Nepal, India, China, Vietnam, Malaysia, Sumatra, Malaysia
20.	*Rhene bufo* (DOL.)	WT	India, Burma, Ambon, Sumatra
21.	*Rhene rubigera* (TH.)	WT	India, China, Vietnam, Sumatra, Mexico
22.	*Siler semiglaucus* (SIMON)	WT	Sri Lanka, Philippines, Sumatra
23.	*Thiania bhamoensis* TH.	WT	China, Vietnam, Burma, Singapore
24.	*Thiania demissa* (TH.)	IP	Sumatra, Java

island, giving the present number of 14 (Table 5). If the whole archipelago is taken into account, the number of species repeatedly recorded in the 1930s and 1990s grows to 8 species (Table 6). Since 1930 or, more likely since the 1952 sterilising eruption, 22 species arrived (on Anak Krakatau), showing a very high colonisation rate – similar to that for Panjang.

Interestingly, the initial colonisation rate is very high, reaching some 20 species during 50-60 years (Panjang case). After that period the equilibrium number is achieved but the turnover rate is still very high. Of all the species recorded, 9 are known from 3 or 4 islands. Fifteen species are established on 1 island only being probably the best candidates for extinction (Table 8). Amongst them there are rainforest inhabitants – usually very sensitive to habitat changes and open ground dwellers endangered by fast succession of flora.

The following reasons seem to cause the high turnover rate of the Krakatau Island salticids: frequent eruptions of Anak Krakatau influencing other islands of the archipelago, fast succession of flora associations, high pressure (expansiveness) of immigrants from Sumatra and Java, and dynamic exchange of faunas between the islands of the archipelago.

T a b l e 8. Number of salticid species on particular islands of the Krakatau archipelago (1984-91).

No. of species	No. of islands
6	4
3	3
9	2
15	1

Zoogeographical elements

The Krakatau salticid fauna consists mostly of widespread, eurytopic species. For obvious reasons there are no endemic taxa there. The new species recorded are, for sure, immigrants from Sumatra and/or Java. Amongst 24 species the following groups can be distinguished (Table 7): (1) Cosmopolitan (cosmotropical) group represented by *Hasarius adansoni*, *Plexippus paykulli* and *Menemerus bivittatus*. (2) Wide tropical elements occurring from India in the west and S China (S Korea, even Japan) in the north through Indochina, Malaysia, Indonesia, New Guinea to the Pacific islands and Australia. Most of them can be found in rainforests but also in grassy habitats. This consists of *Bavia sexpunctata*, *Bristowia heterospinosa*, *Carrhotus sannio*, *Cosmophasis thalassina*, *Evarcha pococki*, *Langona bhutanica*, *Hyllus diardi*, *Portia fimbriata*, *P. labiata*, *Rhene albigera*, *R. bufo*, *R. rubigera*, *Siler semiglaucus*, *Phintella debilis* and *Thiania bhamoensis*. (3) Indopapuan elements found in Sumatra, Java and New Guinea. Probably their limited records are the result of our poor knowledge of the fauna of the area. *Artabrus erythrocephalus*, *Cosmophasis viridifasciata*, *C. laticlavia*, *Cytaea guentheri*, *Neon sumatranus* and *Thiania demissa* represent this group.

Habitat preferences

Rainforest, *Casuarina* forest and grassland are the richest in salticids, contributing 27%, 18% and 17% of specimens, respectively (Table 4). From barren sand and lava and shore vegetation, only from 2% to 4% of specimens were taken. Seven species were collected in at least 3 different habitats, amongst them *Plexippus paykulli*, *Carrhotus sannio* and *Artabrus erythrocephalus*, the first two being successful colonisers of the archipelago since 1931. Amongst the species recorded in one habitat only, there are 6 rainforest and *Casuarina* forest dwellers. At the same time 8 species collected in rainforest were also found in other habitats – mostly in *Casuarina* forest and shore vegetation. Five species were recorded in human habitations, two of them – exclusively (Table 9).

T a b l e 9. Habitat preferences of salticids (1984-91) (S-L- sand, lava, SV- shore vegetation, GR- grassland, CAS- *Casuarina* forest, RF- rainforest, HH- human habitations).

Species	**S-L**	**SV**	**GR**	**CAS**	**RF**	**HH**
1. Plexippus paykulli (SAV et AUD.)	+	+		+	+	+
2. Langona bhutanica PROS.	+			+	+	+
3. Artabrus erythrocephalus (C. L. K.)		+	+		+	
4. Carrhotus sannio (TH.)		+		+	+	
5. Phlegra sp. n.	+		+		+	
6. Siler semiglaucus (SIMON)				+	+	+
7. Thyene sp.		+	+	+		
8. Cosmophasis sp. 2			+	+		
9. Hasarius adansoni (SAV et AUD.)		+			+	
10. Pseudicius sp. n.				+	+	
11. Rhene albigera (C. L. K.)			+	+		
12. Thiania bhamoensis TH.		+	+			
13. Afraflacilla sp. n.		+				
14. Bristowia heterospinosa REIM.				+		
15. Chrysilla sp.				+		
16. Cocalodes sp. n.		+				
17. Cosmophasis sp. 1			+			
18. Cosmophasis sp. 3				+		
19. Cosmophasis sp. 4.				+		
20. Cytaea sp.						+
21. Evarcha pococki ŻABKA					+	
22. Evarcha sp. n.			+			
23. Hyllus diardi (WALC.)				+		
24. Marengo sp. n.					+	
25. Menemerus bivittatus (DUF.)						+
26. Myrmarachne sp.			+			
27. Neon sp. n.				+		
28. Neon sumatranus LOGUNOV			+			
29. Phintella debilis (TH.)					+	
30. Portia labiata (TH.)					+	
31. Telamonia sp.	+					
32. Zenodorus sp. 1					+	
33. Zenodorus sp. 2					+	

Future considerations

1. The data for each island, habitat and zone (altitude and distance from the shore) should be sampled by standardised quantitative methods.
2. The exchange of faunas between particular islands should be analysed.

3. The influence of other groups of arthropods should be analysed and the equilibrium model should be tested, not just for jumping spiders, but for the entire arthropod communities.

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