M.A. JÄCH & L. JI (eds.): Water Beetles of China	Vol. II	25 - 42	Wien, December 1998

Annotated check list of aquatic and riparian/littoral beetle families of the world (Coleoptera)

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Abstract

An annotated check list of aquatic and riparian beetle families of the world is compiled. Definitions are proposed for the terms "True Water Beetles", "False Water Beetles", "Phytophilous Water Beetles", "Parasitic Water Beetles", "Facultative Water Beetles" and "Shore Beetles". *Hydroscapha hunanensis* PU is recorded for the first time from Shaanxi.

Key words: Coleoptera, Water Beetles, aquatic Coleoptera, riparian Coleoptera, key, China.

Introduction

"Is this a Water Beetle ?", I am frequently asked by students, fellow entomologists, ecologists, or limnologists. This seemingly harmless question often turns out to be most disconcerting, especially 1) when the behaviour of that beetle species is not exactly known or 2) when it is known to live in a habitat that is neither truly aquatic nor truly terrestrial, or 3) when it is known to be able to live both subaquatically **and** terrestrially (in the same or in different developmental stages).

There are numerous different types of aquatic habitats containing water of atmospheric origin: oceans, lakes, rivers, springs, ditches, puddles, phytotelmata, seepages, ground water. Most of these biotopes contain numerous types of microhabitats. Excluded are liquids of biogenic origin (e.g., tree sap, fresh cow dung); *Nosodendron fasciculare* (OLIVIER) is for instance not to be regarded as Water Beetle although it can live submerged in a watery fluid.

When dealing with Water Beetles in general one cannot ignore the huge group of so-called "riparian Coleoptera" or Shore Beetles. Aquatic and terrestrial behaviour grade almost imperceptibly into each other at the water's edge. Analogously, one cannot treat riparian beetles without taking into account beetles of marine shores as there exists a natural transition between these as well.

It is often suggested by colleagues that one should regard only those beetles as Water Beetles which have special adaptations to aquatic life (e.g., plastron, swimming hairs, gills, etc.). However, adaptations can be very cryptic (enigmatic) and not readily detectable by taxonomists or ecologists (e.g., special glands, or hydrofuge hairs on certain body parts, physiological adaptations, behavioural adaptations).

Water has been "invaded" several times independently (at least 10 times, acc. to CROWSON 1981: 429) during the evolution of Coleoptera. The water's edge has been "approached" even more often. Thus, the terms Water Beetle and Shore Beetle are not systematic but ecological. This means that it is most essential to know exactly the ecology (and behaviour) of a beetle to decide which type of Water/Shore Beetle it represents. Closely related species may belong to different types. Besides knowing the beetle's behaviour, one must know its exact biotope (habitat, ecological niche).

A treatise on the general biology and evolutionary trends of Water Beetles was published by CROWSON (1981: chapter 13) and I refer the reader to that marvellous contribution for further information.

Among all developmental stages of beetles (eggs, larvae, pupae, adults) larvae and adults are most commonly found under water. Few families are known to have aquatic pupae (e.g., Torridincolidae, Scirtidae, Psephenidae). Our knowledge of the eggs is still very insufficient.

Torridincolidae are furthermore exceptional within Coleoptera as they are reportedly aquatic as larvae, pupae and adults! However, adults are provided with hind wings and it seems probable that they use their hind wings for dispersal flights - so they are supposed to leave their aquatic habitat to be terrestrial for a short time at least. It has not been confirmed that there is any species of Coleoptera that does not leave water for at least a few hours in its individual life. In other words, no Water Beetle is ecologically 100% aquatic as, for example are whales or most fishes.

As far as I am aware nobody has ever worked out a definition or a detailed terminology of the different "types" of Water Beetles and Shore Beetles that undoubtedly do exist.

Definitions

Six ecological groups are distinguished below. The first two groups may be called aquatic because they are in at least one developmental stage "fully" submerged, species belonging to groups 3 - 5 are in most cases amphibious, and the last group is a very large group of generally terrestrial beetles dwelling at the water's edge.

The border between groups 3 and 6 (Facultative Water Beetles and Shore Beetles) is often strongly intergrading and requires exact investigation of the life history of each species.

1. True Water Beetles:

True Water Beetles are submerged (at least partly submerged: adult Gyrinidae!) for most of the time of their adult stage (larvae and pupae may be aquatic or terrestrial). Adults of True Water Beetles are encountered outside of water usually only for dispersal flights, after pupation, for basking in the sun or when environmental conditions turn unfavourable. Members of phytophagous Coleoptera (Chrysomelidae, Brentidae, Curculionidae) are not included herein.

Most of the species live in inland waters, in all kinds of aquatic biotopes and microhabitats; a few species are known from marine rock pools.

All species are provided with conspicuous morphological adaptations: e.g., swimming hairs on legs, divided eyes, plastron, large claws, streamlined body form, etc.

Representatives are found in the following families: Lepiceridae (probably), Torridincolidae, Hydroscaphidae, Gyrinidae, Haliplidae, Noteridae, Amphizoidae, Hygrobiidae, Dytiscidae, Helophoridae, Epimetopidae, Hydrochidae, Spercheidae, Hydrophilidae, Hydraenidae, Elmidae, Dryopidae, Lutrochidae.

2. False Water Beetles:

False Water Beetles are aquatic only in their immature stages, adults always predominantly terrestrial.

False Water Beetles are found in a large variety of running water and stagnant water habitats.

Representatives are found in the following families: Scirtidae, Psephenidae, Ptilodactylidae, Eulichadidae, Lampyridae.

3. Phytophilous Water Beetles:

Phytophilous Water Beetles are members of generally terrestrial phytophagous families. They

are usually mono- or oligophagous and they are closely correlated with the water plants (hosts) they feed/live on and may stay submerged for at least some time in any developmental stage. Their actual habitat is the plant rather than the water body in which the plant grows.

Some species are provided with conspicuous morphological adaptations, e.g., swimming hairs.

Representatives are found in the following families: Chrysomelidae, Brentidae, Curculionidae.

4. Parasitic Water Beetles:

Parasitic Water Beetles are comparable with Phytophilous Water Beetles, except that their hosts are amphibious/aquatic mammals. They are submerged any time their host is submerged.

A few genera of Leiodidae (Psyllinae) are representing Parasitic Water Beetles.

5. Facultative Water Beetles:

Facultative Water Beetles are generally representatives of predominantly terrestrial beetle families. They occasionally (or regularly) and actively stay submerged for a limited period (for hunting, feeding, seeking refuge) in any of their developmental stages.

There are no conspicuous morphological adaptations for aquatic life.

Representatives are found in the following families: Carabidae, ? Leiodidae (Cholevinae: *Hadesia vaseceki* Müller), Staphylinidae, Scarabaeidae (Dynastinae), Lampyridae, ? Monotomidae (*Cyanostolus* Ganglbauer).

6. Shore Beetles:

A huge and heterogeneous group. Shore Beetles are generally terrestrial beetles, but they are found almost exclusively very close to the water's edge (inland waters or marine coast) or in very wet habitats (mud, wet sand) in all their developmental stages.

Beetles inhabiting inland water shores represent the larger group. The term "ripicolous" ("riparian", "riparious") generally refers to all kinds of shore beetles but it is usually (and herein) attributed specifically to margins of inland waters.

Beetles inhabiting marine shores are less common. The term "littoral" is often used ambiguously by scientists. This term generally refers to both inland water and marine habitats and it is here used exclusively for Marine Shore Beetles in the sense of epi-, supra- or eulittoral (according to Schaefer & Tischler 1983).

Epilittoral: living always above the high water mark, outside the reach of the spray zone.

Supralittoral: living almost exclusively closely above the water line (within the spray zone); nonetheless beetles living in that zone may get submerged from time to time due to occasional floods, heavy surges, or due to spray from surges.

Eulittoral: living very close to the water in the zone which gets inundated regularly, e.g., in the intertidal zone.

It shall be noted here that apart from Hong Kong (Cheng & Hill 1980) the beetle fauna of the Chinese littoral is still very poorly known.

Shore Beetles are represented in the following families: Microsporidae, Carabidae, ? Helophoridae, Georissidae, Hydrophilidae, Histeridae, ? Hydraenidae, Ptiliidae, Leiodidae (Cholevinae), Staphylinidae, Scarabaeidae, ? Dryopidae, Limnichidae, Heteroceridae, Elateridae, Lampyridae, Phycosecidae, Melyridae, Monotomidae, Tenebrionidae, Salpingidae, Anthicidae.

Annotated check list of aquatic and riparian beetle families of the world

A total of 43 families is listed herein. An undescribed family of adephagous Water Beetles was

discovered several years ago in South America by my friend Paul J. Spangler (Washington D.C.). This family is not included herein.

Micromalthidae, a family of the suborder Archostemata, were listed as a water beetle family by YANG (1994), because MARSHALL & THORNTON (1963) described the larva of an obviously undescribed species of Micromalthidae which was collected from tap water in Hong Kong, "from areas supplied by different reservoirs, in May 1962, at a period when the water level was extremely low". *Micromalthus debilis* LECONTE is the only species described in this family so far; it is reported from North and South America, Hawaii, and South Africa. COSTA & al. (1988) reported larvae and adults of *M. debilis* to occur sometimes in large quantities in wood inside houses in São Paulo and regarded the species as a pest. South African larvae have been reported from "moist mine timber". It seems likely that the Hong Kong larvae moved downwards following drought and have eventually been trapped in the water reservoirs like in a Berlese funnel. As long as the ecology of the Chinese Micromalthidae is not satisfactorily understood we should not include this family in the water beetle list.

All families listed are provided with an English name (marked with an asterisk (*) if proposed herein for the first time).

Myxophaga

1. Lepiceridae (= Cyathoceridae) False Minute Mudloving Beetles *[1]

This family is comprised of only one genus, *Lepicerus* MOTSCHULSKY, with two known species distributed from Mexico to Venezuela (ARCE-PÉREZ 1997). Adults are usually collected at river margins, often associated with wet detritus. HINTON (1993) collected 30 adults of *L. inaequalis* MOTSCHULSKY (= *L. horni* SHARP) in Mexico from "damp trash piles left in certain protected corners of a canyon by the alternate rising and receding of the river" (translation by SPANGLER 1982). REICHARDT (1976) regarded the adults of *Lepicerus* as aquatic because of the presence of a plastron, however, the ecology of *Lepicerus* still needs to be elucidated. Larvae are still unknown (ARCE-PÉREZ 1997).

2. Torridincolidae Minute Hygropetric Beetles *[2]

This family is comprised of 31 species in seven genera occurring in South America (three genera), Africa (incl. Madagascar) (three genera), and Asia (one genus).

Among all water beetle families, Torridincolidae are probably the "most aquatic" ones - all developmental stages (except maybe the eggs) are aquatic; pupae are provided with spiracular gills. Many species have a preference for hygropetric habitats; several species were collected in mountain streams or water falls.

This family was recorded for the first time from China by JÄCH (1998a).

3. Hydroscaphidae Skiff Beetles

This family is comprised of 3 genera with an almost world-wide distribution (see JÄCH 1995a). Adults and larvae are aquatic (pupae very poorly known), prefering gravel banks of rivers and seepages (fauna hygropetrica).

Two species were recorded by JÄCH (1995a) from China. One of these species, *Hydroscapha hunanensis* PU, was recently collected at a river bank in Shaanxi, 7 km E Zhouzhi, 400 m a.s.l., 108°17'E, 43°09'N. Several females of an unidentified *Hydroscapha* sp. were collected during the China Water Beetle Survey in Hainan.

[1] The general appearance resembles Georissidae (Minute Mudloving Beetles)

[2] Species of this family are usually very small and they are frequently collected in hygropetric habitats

4. Microsporidae (= Sphaeriidae) Minute Bog Beetles

A monogeneric family with world-wide distribution, presently comprised of 23 species (see LÖBL 1995 and ENDRÖDY-YOUNGA 1997). A number of species of *Microsporus* KOLENATI are definitely terrestrial (LÖBL 1995) but others are often collected in sand or gravel on the banks of streams or stagnant water, or in *Sphagnum* moss. It has not yet been thoroughly examined whether adults and larvae of the aquatic/riparian species live permanently or occasionally under water or very close above the water line. More detailed study of the bionomics of these very small beetles (often less than 1 mm long) is greatly appreciated.

No species has so far been recorded from China. However, several specimens of *Microsporus* spp. have been collected during the China Water Beetle Survey. A taxonomic species revision is necessary.

The nomenclatoral stability within this family is threatened by the ruling of "OPINION 1331", published by the International Commission on Zoological Nomenclature (ICZN 1985). Subsequently, a proposal was made by the author (submitted to the ICZN on July 7th, 1997) to suppress "OPINION 1331", to place the family-group name Sphaeriidae ERICHSON, 1845 on the Official List of Rejected and Invalid Family-Group Names in Zoology, and to place the family-group name Sphaeriusidae ERICHSON, 1845 (type genus *Sphaerius* WALTL, 1838) on the Official List of Family-Group Names in Zoology.

A d e p h a g a

5. Gyrinidae Whirligig Beetles

This family is cosmopolitan in distribution with about 700 described species. Adults and larvae of all species are strictly aquatic. They are found in running water and in stagnant water.

MAZZOLDI (1995, 1998) recorded six genera and 50 species from China.

6. Haliplidae Crawling Water Beetles

Haliplidae are widely distributed throughout the world. About 220 species have been described so far (VONDEL 1995). The family is strictly aquatic in the larval and adult stages.

VONDEL (1995, 1998) recorded two genera and 21 species from China.

7. Noteridae Burrowing Water Beetles

Noteridae are widely distributed. About 250 species in two subfamilies have been described so far. They are strictly aquatic. Noterinae are commonly found in stagnant water between roots of water plants. Phreatodytinae, considered as distinct family by certain authors, are restricted to Japanese groundwater habitats.

Three genera and 11 species were recorded from China by NILSSON (1995).

8. Amphizoidae Troutstream Beetles

A monogeneric family with six described species, known so far only from North America and China. Larvae and adults are aquatic living in rather fast flowing rivers.

Three species are known from China (JI & JÄCH 1995, ROUGHLY, XIE & YU 1998).

9. Hygrobiidae Squeak Beetles

A monogeneric family with five described species, one of which occurs in China (see JÄCH 1995b). Larvae and adults are aquatic (stagnant water).

10. Dytiscidae Predaceous Diving Beetles

Found on all continents, this is the largest family of True Water Beetles. More than 3 000 species in six subfamilies have been described so far. Larvae and adults are generally aquatic, living in

a wide variety of aquatic habitats: stagnant water, running water, groundwater; only a few species are known to be fully terrestrial.

A total of 233 species was listed by NILSSON (1995), several species were added to the Chinese fauna since then (e.g., WEWALKA 1997), and numerous species will have to be added to that list as soon as all specimens collected by the China Water Beetle Survey are identified.

11. Carabidae — Ground Beetles

Generally a terrestrial family with more than 20 000 described species. However, a number of species is closely associated with aquatic or riparian habitats; few are reportedly amphibious.

Several species of Carabidae may be found foraging under water (Facultative Water Beetles): Adults and larvae of *Carabus clathratus* L., *C. variolosus* F., *C. menetriesi* HUMMEL (Carabinae) are reported to hunt for snails, crustaceans, insect larvae, tadpoles, and small fish under water. Adults are said to keep air under their elytra (WACHMANN & al. 1995, KLAUSNITZER 1996; see also front cover of The Irish Naturalists' Journal, Special Entomological Supplement 1997). Ulf Drechsel (letter of 2.VIII.1994) reported on two specimens of *Brachygnathus* sp. (Panagaeinae), which he collected in Paraguay, between submerged roots, ca. 15 cm below the water surface.

Other species are reported to stay under water for some time to seek refuge: e.g. *Oodes helopioides* (F.) (Oodinae) and *Chlaenius* BONELLI (Chlaeniinae) (KLAUSNITZER 1996).

Apart from these species which are reportedly actively entering water (Facultative Water Beetles) there are numerous species, which - though rarely found under water - are strongly connected with riparian habitats: e.g., *Agonum* BONELLI (Pterostichinae), *Elaphrus* F., *Blethisa* BONELLI (Elaphrinae), *Loricera* LATREILLE (Loricerinae), *Clivina* LATREILLE, *Dyschirius* BONELLI (Scaritinae), *Tachys* STEPHENS, *Bembidion* LATREILLE (Bembidiinae), *Nebria* LATREILLE (Nebriinae), *Odacantha* PAYKULL (Colliurinae) (KLAUSNITZER 1996). *Aphaenops* (*Hydraphaenops*) spp. (Trechinae) are known to live close to subterranean streams.

The Palearctic genera *Aepus* SAMOUELLE and *Aepopsis* JEANNEL (Trechinae) are reported to be intertidal along the Atlantic coast (TRAUTNER & GEIGENMÜLLER 1987); *Thalassotrechus* VAN DYKE (Trechinae) is reported to be intertidal along the Pacific Coast of California (MCCAFFERTY 1981).

Many of the genera mentioned above occur in China. However, very little is known about the habits of riparian or facultatively aquatic Chinese carabids so far. *Cicindela anchoralis* [= *Abroscelis anchoralis* (CHEVROLAT)] (Cicindelinae) was recorded from Hong Kong beaches by CHENG & HILL (1980).

Polyphaga

12. Helophoridae — Grooved Water Scavenger Beetles [1]

A monogeneric family, more or less confined to the Holarctic Realm. Adults and larvae of most species are usually considered aquatic, but several species seem to be amphibious (facultatively aquatic) as they are often encountered slightly above the water line. Only few species are strictly terrestrial.

Twenty species of *Helophorus* F. were listed by ANGUS (1995) as known or suspected to occur in China.

[1] Pronotum with conspicuous longitudinal grooves

13. Epimetopidae Rugose Water Scavenger Beetles [4]

Three genera and 27 species are known from South America, tropical Africa and tropical Asia (JI & JÄCH 1998b). Larvae and adults are aquatic.

Only one species is known from China. The family has been recorded from China for the first time by JI & JÄCH (1998b).

14. Georissidae Minute Mudloving Beetles

A monogeneric family being found in all major biogeographic regions. About 70 species have been described so far. The species are generally riparian in all stages. They are supposed to have "reverted" to terrestrial habits from aquatic ancestors.

Georissus LATREILLE occurs in China, but the genus was not treated by WU (1937) and it is in need of a taxonomic revision.

15. Hydrochidae Elongated Water Scavenger Beetles [5]

Another monogeneric family (the genus *Kiransus* MAKHAN is a junior synonym of *Hydrochus* LEACH, see HANSEN 1998) with a world-wide distribution. About 200 species have been described so far. All species are aquatic, living in stagnant water and/or in rather slowly flowing water.

The genus was frequently collected by the China Water Beetle Survey in eastern China (Fujian, Guangxi, Hainan, Hong Kong, Hunan, Jiangxi), but the Asian species are in need of a thorough taxonomic revision. Only two species, *H. japonicus* SHARP and *H. binodosus* MOTSCHULSKY, were hitherto recorded from China (*H. annamita* RÉGIMBART is a junior synonym of *H. japonicus*, see BALFOUR-BROWNE & SATÔ 1962). JIA (1996) recorded *H. annamita* (= *H. japonicus*) from Shanghai, Hubei, Hunan, Jiangxi, Fujian, Guizhou, Sichuan, Yünnan, Guangxi, Guangdong and Hainan. The same author (JIA 1996) recorded *H. binodosus* for the first time from China (Hunan, Guizhou, Guangxi, Guangdong), however, the determination is likely to be incorrect.

16. Spercheidae Filterfeeding Water Scavenger Beetles [6]

A monogeneric family with almost world-wide distribution. Sixteen species are recognized presently (HEBAUER 1997). Larvae and adults generally live in stagnant water.

The family was recorded from China (Heilongjiang) for the first time by JIA (1996). The species recorded by JIA (1996) from Heilongjiang might belong to the wide-spread Euro-Siberian *Spercheus emarginatus* (SCHALLER) which has been recorded from the Russian Far East by SHATROVSKIY (1989).

17. Hydrophilidae Water Scavenger Beetles

A large family (four subfamilies with ca. 140 genera and more than 2 000 species) with world-wide distribution.

Horelophinae: monotypical subfamily from New Zealand, possibly hygropetric (HANSEN 1991).

Horelophopsinae: monotypical subfamily from New Guinea (Yapen Island), probably terrestrial (HANSEN 1997).

Hydrophilinae: ca. 50 genera, adults and larvae mostly living in stagnant water, running water or in hygropetric habitats.

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[4] Surface often rugosely sculptured

[5] Body form conspicuously elongate

[6] Adults with a remarkable filter feeding habit (ROTHMEIER & JÄCH 1986)

Sphaeridiinae: ca. 90 genera, most of which are terrestrial; rather few species are aquatic/riparian.

The Chinese Hydrophilinae were compiled by GENTILI & al. (1995). They listed 123 species. Eight species were added by JI & SCHÖDL (1998) and HEBAUER & WANG (1998).

18. Histeridae Hister Beetles

A generally terrestrial family. Representatives of *Hypocaccus* THOMSON and *Neopachylopus* REICHARDT are reported to live in "littoral habitats" (YANG 1994).

Hypocaccus is reported from China.

19. Hydraenidae Minute Moss Beetles

A cosmopolitan family with more than 20 genera and more than 1 000 described species (JÄCH 1995c). Adults of most species are aquatic (stagnant water, running water, hygropetric) or riparian. Some appear to be amphibious (facultatively aquatic) or riparian. A few species are known to live exclusively in hypersaline marine rock pools and a few species are strictly terrestrial. Larvae are usually not aquatic.

A total of 54 species was recorded from China by JÄCH (1995c), JÄCH & DÍAZ (1998) and JÄCH (1998b, c).

20. Ptiliidae Featherwinged Beetles

A generally terrestrial family with world-wide distribution. About 560 species are described so far (M. Sörensson, pers. comm.).

Numerous species are found under more or less wet decaying organic matter. A number of species is reported to be riparian/littoral. *Ptenidium longicorne* FUSS and numerous species of the world-wide genus *Actidium* MATTHEWS (e.g., *A. aterrimum* MOTSCHULSKY, *A. reticulatum* BESUCHET, *A. variolatum* FLACH) are abundant at river banks and stream margins; *Actidium boudieri* ALLIBERT lives in bogs and marshes; others, such as *Actidium kraatzi* FLACH live in salt marshes (M. Sörensson, pers. comm.); *Actidium coarctatum* HALIDAY and the species of the genus *Actinopteryx* MATTHEWS are reported to occur in decaying seaweed on coasts.

Almost nothing is known about the Chinese ptiliid fauna.

21. Leiodidae Round Fungus Beetles

A generally terrestrial family, including six subfamilies: Camiarinae, Catopocerinae, Leiodinae, Coloninae, Cholevinae (= Catopinae, incl. Bathysciinae), Platypsyllinae (= Leptininae) (LAWRENCE & NEWTON 1995); at least two of these subfamilies have "aquatic" representatives.

Platypsyllinae (Mammal-Nest Beetles): *Platypsyllus castoris* RITSEMA must be regarded as Parasitic Water Beetle, because it occurs regularly on the bodies of beavers (*Castor fiber* L.) and thus gets submerged frequently. A similar ecology is recorded from *Silphopsyllus desmanae* OLSUFIEW which is known to live on the water mole (*Desmana moschata* L.).

In China, the beaver is restricted to the Altay Mountains (Xinjiang). The water mole occurs in Europe only.

Cholevinae: The Bosnian cave beetle *Hadesia vaseceki* was regarded as strictly aquatic by early authors (ABSOLON 1915, CHAPPUIS 1927). However, REMY (1940) pointed out that *Hadesia* never gets submerged voluntarily, but he confirms that *Hadesia* is "extremely hygrophilous". Undoubtedly, *Hadesia vaseceki* is a beetle with a very interesting biology (it has been observed filtering the water of subterranean seepages for food) which deserves to be investigated more thoroughly. Another closely related southeast European cave beetle genus, *Antroherpon* REITTER, was reported by REMY (1940) to live close to subterranean streams.

22. Staphylinidae Rove Beetles

One of the largest coleopterous families, with ca. 30 subfamilies (after LAWRENCE & NEWTON 1995), and more than 30 000 described species, most of which are strictly terrestrial. However, numerous species are known to be riparian:

Margins of streams and rivers: Omaliinae: *Hygrogeus aemulus* (ROSENHAUER), *Lesteva* spp., *Geodromicus* spp., Oxytelinae: *Deleaster* spp., *Ochthephilus* spp., *Bledius* spp., *Sartallus* spp., *Thinobius* spp., Steninae: *Dianous* spp., *Stenus* spp., Paederinae: *Paederus* spp., *Scopaeus* spp., *Lathrobium* spp., *Pseudobium* spp., *Enallagium* spp., *Dysanabathium* spp., *Cephalochaetus* spp.; Staphylininae: *Gauropterus* spp. *Philonthus* spp. (especially *atratus* group, *umbratilis* group, *nigrita* group, *quisquiliarius* group), *Gabrius* spp., *Quedius riparius* KELLNER; Aleocharinae: *Tachyusa* spp., *Ischnopoda* spp., *Gnypeta* spp., *Aloconota* spp., *Apimela* spp., *Blepharrhymenus* spp., *Parocyusa* spp., *Ocalea* spp., *Hygropetrophila grandis* (FAUVEL), *Aleochara* spp., *Thinoecia* spp., *Hydrosmecta* spp., *Actocharina leptotyphloides* BERNHAUER (after KLAUSNITZER 1996, LAWRENCE & BRITTON 1994, Schillhammer, pers. comm.).

Margins of stagnant waters: Omaliinae: *Arpedium quadrum* (GRAVENHORST), *Olophrum* spp.; Oxytelinae: *Manda mandibularis* (GYLLENHÅL), *Planeustomus* spp., *Carpelimus* spp., *Platystethus* spp.; Steninae: *Stenus* spp.; Paederinae: *Paederus* spp., *Scopaeus* spp., *Leptobium* spp., *Lathrobium* spp., *Scimbalium* spp., *Achenium* spp.; Staphylininae: *Platyprosopus* spp., *Neobisnius* spp., *Erichsonius* spp., *Philonthus* spp. (*quisquiliarius* group, *micans* group), *Gabrius* spp., *Gabronthus* spp., *Acylophorus* spp.; Atanygnathinae: *Atanygnathus* spp.; Aleocharinae: *Hygronoma dimidiata* GRAVENHORST, *Brachyusa concolor* (ERICHSON), *Dacrila fallax* (KRAATZ), *Alianta incana* (ERICHSON), *Pachnida nigella* (ERICHSON), *Dochmonota clancula* (ERICHSON), *Ischnopoda* spp., *Gnypeta* spp., *Tomoglossa* spp., *Schistoglossa* spp., *Atheta* spp., *Calodera* spp., *Deubelia picina* (AUBÉ), *Ocyusa maura* (ERICHSON), *Aleochara brevipennis* GRAVENHORST (after KLAUSNITZER 1996, Schillhammer, pers. comm.).

Sphagnum bogs: Steninae: *Stenus* spp.; Euaesthetinae: *Euaesthetus* spp.; Paederinae: *Lathrobium* spp., *Cryptobium fracticorne* (PAYKULL); Staphylininae: *Philonthus* spp., *Quedius boopoides* MUNSTER, *Acylophorus* spp.; Atanygnathinae: *Atanygnathus terminalis* (ERICHSON); Tachyporinae: *Tachyporus transversalis* GRAVENHORST, *Bolitobius formosus* (GRAVENHORST); Aleocharinae: *Deinopsis erosa* STEPHENS, *Schistoglossa* spp., *Atheta* spp., Pselaphinae spp. (after KLAUSNITZER 1996, MCCAFFERTY 1981, Schillhammer, pers. comm.).

Marine coasts: Omaliinae: *Omalium* spp., *Micralymma marinum* STROEM; Oxytelinae: *Actocharis marina* FAUVEL, *Anotylus maritimus* THOMSON, *Bledius* spp., *Carpelimus* spp., *Sartallus* spp.; Staphylininae: *Cafius* spp., *Orthidus* spp., *Liusus* spp., *Hadropinus fossor* SHARP, *Quedius simplicifrons* FAIRMAIRE; Aleocharinae: *Diglotta* spp., *Phytosus* spp., *Xenusa* spp., *Halobrecta* spp., *Brundinia* spp., *Atheta vestita* (GRAVENHORST), *Aleochara* spp., *Liparocephalus* MAEKLIN, *Diaulota* CASEY, *Bryothinusa* CASEY, *Amblopusa* CASEY (after KLAUSNITZER 1996, LAWRENCE & BRITTON 1994, WHITE & BRIGHAM 1996, WONG & CHAN 1977, Schillhammer, pers. comm.).

Micralymma WESTWOOD (Omaliinae), *Liparocephalus* spp., *Diaulota* spp. (Aleocharinae), *Phucobius simulator* SHARP (Staphylininae) are reported to be intertidal (CROWSON 1981, EASTON 1991, KLAUSNITZER 1996, MCCAFFERTY 1981).

However, only few species are reported to stay submerged voluntarily: *Stenus fornicatus* STEPHENS (Steninae), *Lesteva* spp. (Omaliinae).

Very little is known about the Staphylinidae of China. Only very few of the riparian genera have been treated in taxonomic revisions (e.g., ZHENG 1993).

23. Scarabaeidae Scarab Beetles

A cosmopolitan family with more than 10 subfamilies. Most members of this family are strictly terrestrial.

Dynastinae: some New World species (e.g., *Dyscinetus morator* F.) are reported to be able to spend several hours under water while escaping disturbances or while feeding on water plants (e.g. *Eichhornia crassipes*) (see BUCKINGHAM & BENNET 1989). Since *D. morator* obviously is not monophagous (it also feeds on terrestrial plants, such as carrots and radishes) I prefer to list it under Facultative Water Beetles instead under Phytophilous Water Beetles.

No aquatic Dynastinae are recorded from China.

Aphodiinae: Some Psammodiini species are known to be riparian, found often very close to the water margin together with Heteroceridae and other typical shore beetles.

Several species are found in China.

24. Scirtidae (= Helodidae) Marsh Beetles

A cosmopolitan family with ca. 1 000 described species. The larvae are usually aquatic while the adults are generally terrestrial (adults of *Hydrocyphon* appear to be amphibious). Pupae are usually terrstrial, but pupae of *Hydrocyphon* spp. are regularly collected under water. Larvae are found in stagnant water, in running water, and in groundwater.

The scirtid fauna of China is very poorly studied; only six species were recorded by KLAUSNITZER (1995).

25. Elmidae Riffle Beetles [7]

A moderately large cosmopolitan family (with ca. 120 genera and more than 1 200 species) which includes two subfamilies (JÄCH & KODADA 1995). Adults and larvae are usually considered to be aquatic, however, adults of many Larainae species are often encountered a little above the water line or in spray zones of water falls and cascades. Members of this family are generally living in lotic habitats, few species are encountered in lakes or ponds.

A total of 50 species was recorded from China by JÄCH & KODADA (1995); ZHANG & DING (1995), ZHANG & YANG (1995) and ZHANG & al. (1997) added eight species and one subspecies; ČIAMPOR & KODADA (1998) and SHEPARD (1998) added five species.

26. Dryopidae Longtoed Water Beetles

A family with world-wide distribution. About 24 genera and 240 species have been described so far (KODADA & JÄCH 1995). Larvae are generally terrestrial in this family and in about 80 % of the species, the adults are known to be aquatic (lotic and lentic habitats). Some species are possibly riparian.

Seventeen species were recorded from China by KODADA & JÄCH (1995).

27. Lutrochidae False Minute Marshloving Beetles [8]

A poorly studied New World family which has close phylogenetical relationships with Limnichidae, Dryopidae, Chelonariidae and Elmidae. Only one genus and ca. 15 species have been described so far. Larvae and adults are reported to be aquatic (COSTA & al. 1996) in lotic habitats.

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[7] Riffle Beetles is the most commonly used English name for Elmidae, however, the name "Drive Beetles" was used by ARNETT (1971)

[8] General appearance resembles that of Limnichidae (Minute Marshloving Beetles) to which they are closely related

Lutrochidae occur from the USA to Argentina. They have not been collected in China so far.

28. Limnichidae Minute Marshloving Beetles

Five subfamilies with more than 35 genera and more than 220 species of Limnichidae are known world-wide (WOOLDRIDGE 1986). Their taxonomy and bionomics are very poorly studied so far. Larvae and adults of most species are reported to live along shores of freshwater habitats. Several species are known to be intertidal in coral reefs: *Babalimnichus* spp. (see SATÔ 1994), *Hyphalus* spp. (see LAWRENCE & BRITTON 1994). At least a few species are obviously fully terrestrial (WOOLDRIDGE 1986).

PÜTZ (1998) listed 18 Chinese limnichids.

29. Heteroceridae Variegated Mudloving Beetles

An almost cosmopolitan family (so far not recorded from New Zealand), which is comprised of 5 genera and about 200 species (MASCAGNI 1995). Adults and larvae are typical Shore Beetles, which dig in wet sand and mud, preferably near freshwater.

Ten species were recorded from China by MASCAGNI (1995).

30. Psephenidae Water Pennies

An almost cosmopolitan family (not recorded from New Zealand) with four subfamilies, 28 genera and about 150 described species. Larvae are generally aquatic, usually in running water, adults are generally terrestrial (however, adults and pupae of *Psephenoides* GAHAN are frequently collected under water).

A total of 28 species was recorded from China by LEE & JÄCH (1995), YANG (1995, 1997), LEE, YANG & SATÔ (1998) and LEE, JÄCH & YANG (1998).

31. Ptilodactylidae Toed-Winged Beetles [*9]

A moderately large and diverse family with 5 subfamilies (acc. to LAWRENCE & NEWTON 1995), with ca. 25 genera and ca. 500 species (acc. to LAWRENCE & STRIBLING 1992), and with almost world-wide distribution (not native in Europe - *Pseudodactylus* HAMPE was synonymized with *Eurypogon* MOTSCHULSKY, which belongs to Artematopodidae). The Ptilodactylidae species are taxonomically badly in need of a revision. The larvae of several species are known to be aquatic (usually lotic habitats). Adults seem to be terrestrial throughout.

Almost nothing is known about the Chinese representatives of this family.

32. Eulichadidae Forest Stream Beetles [*10]

A small family with 2 genera and 21 described species (JÄCH 1995d). Larvae live in streams, adults are strictly terrestrial.

JÄCH (1995d) recorded six species from China.

33. Elateridae Click Beetles

A large family with primarily terrestrial representatives found on all continents. About 12 000 species have been described so far.

[*9] This name was used by ARNETT (1971)

[*10] These beetles are usually found in and near forest streams

According to KLAUSNITZER (1996) at least the larvae of the following genera have riparian representatives: *Oedostethus* LECONTE, *Negastrius* THOMSON, *Zorochrus* THOMSON (Negastriinae), *Hypnoidus* DILLWYN (Hypnoidinae), *Adrastus* ESCHSCHOLTZ, *Betarmon* KIESENWETTER (Elaterinae), *Dicronychus* BRULLÉ, *Paracardiophorus* SCHWARZ (Cardiophorinae), *Drasterius* ESCHSCHOLTZ (Agrypninae), and *Actenicerus* KIESENWETTER (Ctenicerinae).

At least some of these genera occur in China.

34. Lampyridae Fire Flies

A family with world-wide distribution, about 2 000 species have been described in 92 genera (MCDERMOTT 1966).

Most species of Lampyridae are terrestrial or at most riparian/littoral. However, the larvae of a few species (e.g., *Luciola cruciata* MOTSCHULSKY from Japan, *L. ficta* OLIVIER from China) are strictly aquatic and provided with gills. The larvae of some species are reported to be facultatively aquatic (e.g., *Pristolycus kanoi* NAKANE from Taiwan), others are known to be riparian. Adults and larvae of *Luciola afrogeneia* BALLANTYNE & BUCK were reported from the spray zone of coastal coral rocks in New Guinea (LLOYD 1973); larvae were observed underwater in rock pools as well as above water.

The aquatic/riparian larvae are reported from a variety of habitats: running water (streams and rivers), paddy fields, small ditches, seepages, water falls, etc.

Fifty-six species of Lampyridae were reported from Mainland China by WU (1937). LAI & al. (in press) listed 44 species from Taiwan. Only few of these species are considered to be aquatic, amphibious (facultatively aquatic), or riparian.

35. Phycosecidae Beach Beetles

A monogeneric family (*Phycosecis* PASCOE) with few species. Larvae and the wingless adults occur in sand dunes along coasts of Australia, New Caledonia, New Zealand, and Vanuatu, where they are scavengers feeding on dead vertebrates and insects.

Phycosecis has not been collected in China so far.

36. Melyridae Softwinged Flower Beetles

A large cosmopolitan family which includes 5 subfamilies (acc. to LAWRENCE & NEWTON 1995). One of these subfamilies (Malachiinae) contains a number of species, which occur along ocean beaches: The North American *Endeodes* spp. (wingless with very short elytra) and some members of the widely distributed genus *Laius* GUÉRIN-MÉNEVILLE. *Endeodes* spp. are reported to occur "in rock crevices and along sandy beaches of the Pacific coast" (MCCAFFERTY 1981). I collected the type specimens of *Laius ambonensis* WITTMER in large numbers on a stranded tree on a sandy beach on Pombo Island (Moluccas, Indonesia). The tree was exposed to sunlight, several meters from the water line; however, it seems most likely that the tree plus its beetles do get wet or submerged during heavier surge (supralittoral). YANG (1994) reports on *Laius* spp. inhabiting "the surfaces of reefs".

The genus *Laius* has been recorded from China by WINKLER (1926), but I do not know whether there are Shore Beetles among them or not.

37. Monotomidae Rooteating Beetles

A widespread family. Most species are terrestrial, living under bark. *Cyanostolus aeneus* (RICHTER) was reported from submerged wood in streams and rivers (? Facultative Water Beetle). PEACOCK (1978) interpreted its metepisternal hair pile as plastron. *Phyconomus marinus* LECONTE occurs "under driftwood in the upper intertidal area of the California coast" (MCCAFFERTY 1981).

Phyconomus has not been collected in China so far.

38. Tenebrionidae Darkling Beetles

A very large cosmopolitan family with about 18 000 described (primarily terrestrial) species (with eight subfamilies, sensu LAWRENCE & NEWTON 1995).

Epantius sp. is recorded from the "upper intertidal area of the California coast" (MCCAFFERTY 1981). The Australian *Sphargeris physodes* PASCOE is reported to be "usually found in masses of drying seaweed" (LAWRENCE & BRITTON 1994). Several other species, e.g., *Caediomorpha heteromera* KING, *Caedius sphaeroides* HOPE and *Trachyscelis* spp. were also reported to be widely distributed on ocean beaches. *Scymaena* spp. and *Trachyscelis* spp. live in sand beneath dune plants (LAWRENCE & BRITTON 1994).

Gonocephalum pseudopubens KASZAB was reported from Hong Kong shores (CHENG & HILL).

39. Salpingidae Narrowwinged Bark Beetles

A moderately large family with world-wide distribution (with seven subfamilies, acc. to LAWRENCE & NEWTON 1995). Members of this family are generally terrestrial.

The members of the northern Pacific and subantarctic subfamily Aegialitinae (*Aegialites* spp.) are reported to be intertidal (LAWRENCE & BRITTON 1994).

YANG (1994: p. 383) erroneously listed Elacatidae (= Salpingidae, Othniinae) (False Tiger Beetles) as aquatic, which results from a confusion with Aegialitinae.

So far, Aegialitinae have not been recorded from China.

40. Anthicidae Antlike Flower Beetles

A moderately large and widely distributed family of primarily terrestrial beetles. There are 10 subfamilies according to LAWRENCE & NEWTON (1995).

A few species (e.g. *Cordicomus sellatus* (PANZER), *Anthicus luteicornis* SCHMIDT) are reported to be ripicolous (KLAUSNITZER 1996). *Lagrioida australis* CHAMPION is reported to be a "beach inhabitant, living in the sand between dune plants" in Australia (LAWRENCE & BRITTON 1994).

41. Chrysomelidae Leaf Beetles

A very large beetle family, with about 50 000 described species, most of which are strictly terrestrial. Of the 10 presently acknowledged subfamilies (see LAWRENCE & NEWTON 1995) the following are noteworthy:

Donaciinae: *Donacia* FABRICIUS, *Plateumaris* THOMSON, *Macroplea* SAMOUELLE are exclusively found on aquatic or riparian vegetation (e.g., *Potamogeton*, *Ruppia*, *Phragmites*, *Sparganium*, *Typha*, *Nymphaea*, *Nuphar*, *Sagittaria*, *Alisma*, *Glyceria*, *Carex*, *Butomus*) above and/or below the water surface.

Five genera and about 25 species of Donaciinae have been recorded from China (YANG 1994).

Galerucinae: Several species of Galerucinae (incl. Alticinae) are living on emergent aquatic plants (usually above the water surface): *Galerucella* spp. (*Nuphar*, *Nymphaea*); *Altica* spp. (*Ludwigia*); *Agasicles hygrophila* SELMAN & VOGT - this species was introduced into the USA from South America to control alligatorweed (*Alternanthera*) and it has proven to be very effective in this task; *Longitarsus nigerrimus* (GYLLENHÅL) lives on *Utricularia* and can stay under water for a long time (MOHR 1960); *Lysathia ludoviciana* FALL (*Myriophyllum*) and *Pseudolampsis guttata* LECONTE (*Azola*) were also reported to feed on aquatic plants (see WHITE & BRIGHAM 1996).

Chrysomelinae: *Hydrothassa* spp. and one species of *Prasocuris* LATREILLE were reported to be "aquatic or semiaquatic" by WHITE & BRIGHAM (1996).

Numerous genera are reported to occur on rice: *Lema* F., *Oulema* DES GOZIS (Criocerinae), *Dactylispa* WEISE, *Dicladispa* GESTRO, *Hispellinus* WEISE, *Rhadinosa* WEISE (Hispinae).

42. Brentidae Straight-snouted Weevils

A cosmopolitan family of phytophagous beetles which is comprised of six subfamilies (LAWRENCE & NEWTON 1995), two of which (Nanophyinae, Apioninae) were formerly placed in Curculionidae.

One species of *Nanophyes* SCHÖNHERR (Nanophyinae) was reported to feed in the stems of the water plant *Ludwigia* (LAWRENCE & BRITTON 1994).

43. Curculionidae Weevils

The world's largest beetle family (there are probably more than 60 000 described species) with presently (LAWRENCE & NEWTON 1995) six recognized subfamilies: Brachycerinae, Cossoninae, Curculioninae (incl. Bagoinae, Ceutorhynchinae, Cleoninae, Erirhinae, Lixinae, Molytinae, Notarinae, Tanysphyrinae), Dryophthorinae, Platypodinae, Scolytinae.

Numerous Phytophilous Water Beetles are reported in Curculioninae: e.g., *Bagous* GERMAR, *Erirhinus* SCHÖNHERR, *Eubrychius* THOMSON, *Grypus* STEPHENS, *Icaris* TOURNIER, *Lissorhoptrus* LECONTE, *Neophytobius* WAGNER, *Notaris* GERMAR, *Pelenomus* THOMSON, *Rhinoncus* STEPHENS, *Stenopelmus* SCHÖNHERR, *Tanysphyrus* SCHÖNHERR (see CALDARA & O'BRIEN 1995, KLAUSNITZER 1996).

Aphela spp. (Brachycerinae) were reported by LAWRENCE & BRITTON (1994) to occur in sand beneath dune plants.

Scolytinae (Bark Beetles) are still regarded as a distinct family by numerous authors. *Coccotrypes rhizophorae* (HOPKINS) is known to attack the seeds of the mangrove tree *Rhizophora mangle* soon after they fall to the ground (WOODRUFF 1970).

CALDARA & O'BRIEN (1995) listed 29 species of aquatic weevils from China.

Acknowledgements

D.S. Boukal, D. Bright, P. Cate, U. Drechsel, E.R. Easton, G.N. Foster, M.-L. Jeng, L. Kirkendall, E. Kirschenhofer, O. Merkl, A.F. Newton, M. Sörensson, H. Schillhammer, H. Schönmann, R. Schuh, and D. Telnov are thanked sincerely for their comments and suggestions.

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