

From the Table 1, it is apparent that Kalyadi pyrites from stratiform sulphide ores have Co/Ni ratio higher (2–10) than the pyrites of sedimentary origin (Co/Ni = 0.8)^{3,11} and are similar to the Big Cadia Copper deposit in Australia and other Canadian and Chinese Archean Copper deposits of probable exhalative origin^{13,14}. Further, the Ni concentration in Kalyadi pyrites is lower relative to pyrites associated with submarine exhalative sulphide deposits. Thus Co and Ni values in Kalyadi pyrites indicate their derivation from a volcanogenic source. The remobilized hydrothermal vein type ores show lower Co content as well as a low Co/Ni ratio than the stratiform type of ores¹⁵. Thus the primary stratiform ores are enriched in cobalt.

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Component community structure of larval trematodes in the snail *Cerithium scabridum* from southern Kuwait Bay

Our knowledge about the ecology of parasites has been substantially enriched by studies on larval trematode communities in snail intermediate hosts. Esch and Fernandez¹ reviewed various factors contributing to structuring of trematode communities and concluded that behaviour of the definitive hosts and population dynamics of the intermediate hosts are among the major external factors while interspecific antagonistic interactions among larval forms is the major internal factor.

Members of the gastropod family Cerithidae, also known as creepers or ceriths, are common inhabitants of sandy and muddy intertidal zones of tropical and subtropical coasts. Larval forms representing all major groups of trematodes have been reported in ceriths from different geographical regions; the Great Barrier Reef^{2,3}, the Caribbean^{4,5}, the Gulf of Mexico⁶, Japan and adjacent territories⁷, and the Mediterranean⁸. In Kuwait Bay, Abdul-Salam *et al.*⁹ reported 9 cercarial types in the cerith *Clypeomorus bifasciata* (Sowerby 1855). The present study presents information on the component community of larval trematodes parasitizing a population of *Cerithium scabridum* Philippi, 1848 from a site south of Kuwait Bay.

C. scabridum occurs in large aggregates on sand overlaying limestone platform along the Amiri beach in Kuwait city, southern Kuwait Bay. The beach is completely exposed twice a day. During a low tide, the vast intertidal zone is a major habitat for large populations of indigenous and migratory aquatic birds. Samples of *C. scabridum* were collected at monthly intervals from October 1997 to March 1998. Snails were studied by crushing the shell and examining the tissues for larval stages under a dissecting microscope. The larvae were examined live, unstained or vitally stained with 5.0% neutral red. Details of the life cycles of all of the recovered trematodes are not known and they can only be identified to family level according to their diagnostic features, as described by Cable⁴ and Schell¹⁰.

A total of 2072 snails ranging in shell height from 5.0 to 17.0 mm were examined, and 83 (4.0%) were infected with 12 species of trematodes representing 8 families. Prevalence of the trematodes and their probable life cycles are shown in Table 1. Highest prevalence was recorded for microphallid II (1.45%) followed by the philophthalmid (1.30%), and the overall prevalence increased with snail shell height (Figure 1). Multiple larval

infection was not encountered in any of the examined snails.

In Kuwait Bay, *C. scabridum* is involved in the life cycle of at least 12 species of trematodes, 9 are known to occur as adults in aquatic birds. The trematode fauna in the snail was dominated by microphallid II. A preliminary survey of intertidal crabs and the gull *Larus argentatus* from the study area revealed common occurrence of infections with microphallid metacercariae and adults, respectively. The overall prevalence of infections increased exponentially with shell size (age), a common phenomenon in marine^{11,12} as well as fresh water¹³

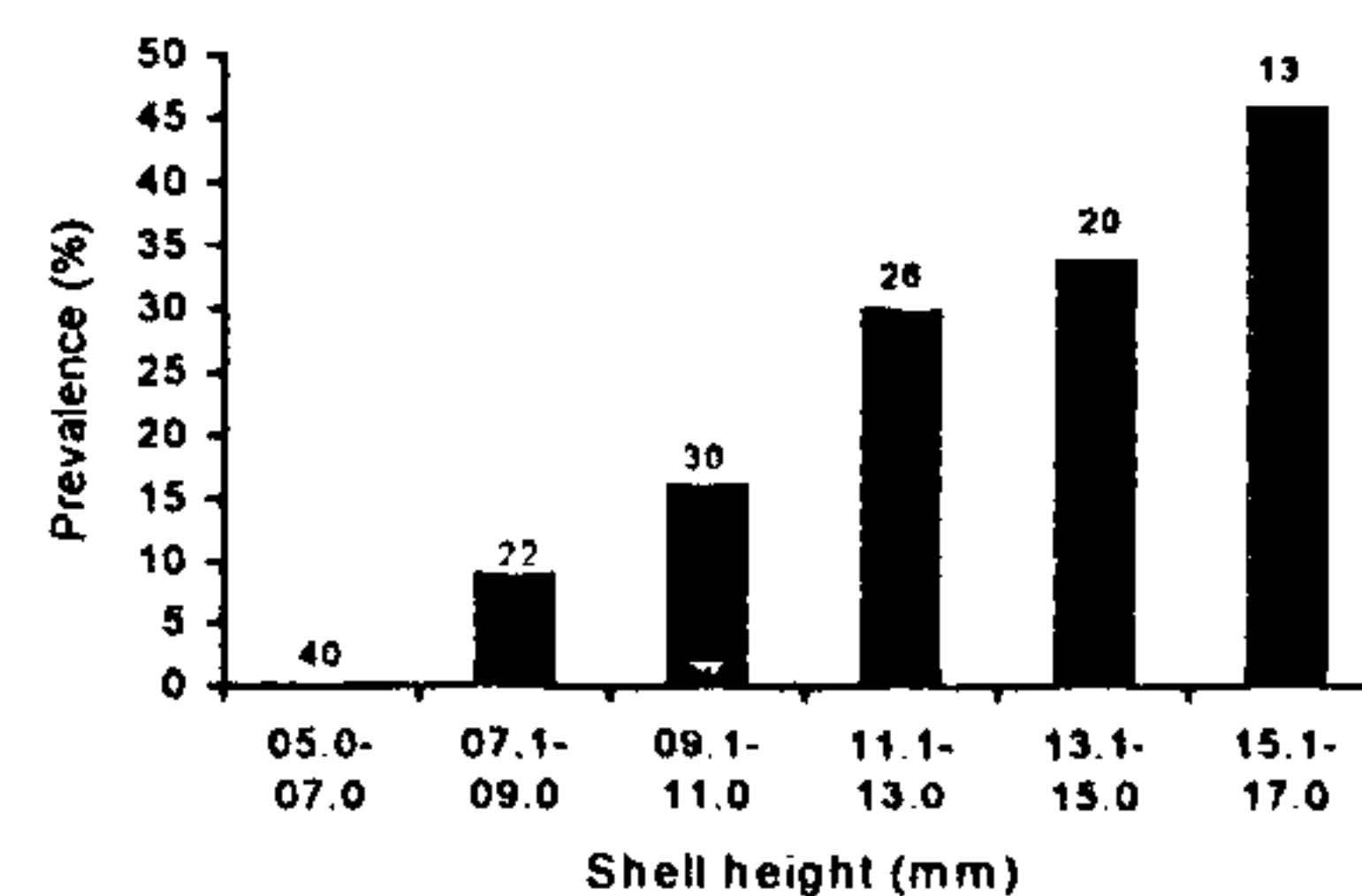


Figure 1. Prevalence of larval trematode infections relative to shell height of the snail *Cerithium scabridum* from Kuwait Bay. The number of snails examined is indicated at the top of each bar.

Table 1. Prevalence and possible life cycle patterns for trematode infections in the snail *Cerithium scabridum* from Kuwait Bay ($n = 2072$)

Trematode infection	Prevalence %	Possible life cycle pattern
Bivesiculid	01 (0.05)	Snail-fish
Echinostome I	03 (0.15)	Snail-mollusc-bird
Echinostome II	03 (0.15)	Snail-mollusc-bird
Hemiurid	01 (0.05)	Snail-copepod-fish
Heterophyid I	01 (0.05)	Snail-fish-bird
Heterophyid II	01 (0.05)	Snail-fish-bird
Microphallid I	03 (0.15)	Snail-crab-bird
Microphallid II	30 (1.45)	Snail-crab-bird
Microphallid III	09 (0.43)	Snail-crab-bird
Opecoelid	01 (0.05)	Snail-crab-fish
Philophthalmid	27 (1.30)	Snail-external-bird
Renicolid	03 (0.15)	Snail-fish-bird
Total	83 (4.00)	

snails, and often attributed to either prolonged survival of infected snails, or increased probability of ultimately becoming infected¹⁴. Absence of multiple infections during the present study may be attributed in part to temporal heterogeneity in the availability of infective stages; the chances may have been higher if the sampling coincided with peak recruitment for multiple species. Antagonistic interactions among larval stages have also been implicated in structuring infracommunities in snail-trematode systems¹.

The component community of trematodes in *C. scabridum* showed striking similarity to those reported in ceriths from other subtropical regions²⁻⁵. The trematodes fauna in *C. scabridum* included 8 species, i.e. the philophthalmid, the hemiurid, echinostome I and II, microphallid II and III, the opecoelid, and the

bivesiculid, shared with assemblages in *Clypeomoros bifasciata* from the same general locality¹⁵. Poulin¹⁶ concluded that the development of parasite assemblage at large spatial and temporal scales proceeds through a series of evolutionary events, determined in part by the characteristics of the habitat or the host. The assemblages of trematodes in *C. scabridum* in Kuwait Bay is probably influenced by a set of temperature-related factors including changes in population dynamics of the snail, death of infected and recruitment of new uninfected ones, intramolluscan development of the larval stages, and behaviour of the hosts involved in the cycle.

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