POPULATION DYNAMICS OF SNAIL LYMNAE RUBIGINOSA IN RICE FIELDS AND ITS INFECTION WITH LARVAE OF TREMATODES IN THE SUBDISTRICT OF SURADE, WEST JAVA

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ABSTRAK

SUHARDONO and D.B. COPEMAN. 2000. Dinamika populasi siput *Lymnaea rubiginosa* di sawah padi dan infeksinya oleh larva trematoda di Kecamatan Surade, Jawa Barat. *Jurnal Ilmu Ternak dan Veteriner* 5(4): 241-249.

Lahan sawah padi irigasi merupakan habitat yang sangat cocok untuk berkembang-biakan siput *Lymnaea rubiginosa* yang merupakan induk semang antara cacing *Fasciola gigantica* dan trematoda lainnya. Fluktuasi populasi siput *L. rubiginosa* di sawah padi irigasi dan infeksinya dengan larva F. gigantica dan trematoda lainnya telah diteliti di lima desa di Kecamatan Surade, Propinsi Jawa Barat. Siput disampel berdasarkan waktu, yaitu 30 menit-arang setiap lokasi. Selanjutnya, siput dihitung dan diperiksa terhadap adanya larva cacing trematoda. Hasil penelitian menunjukkan bahwa sebagian besar siput mati pada musim kemarau, kecuali yang tinggal di sisa-sisa genangan air seperti selokan dan mata air. Siput yang masih hidup ini akan tersebar lagi di sawah padi di sekitar pemukiman dengan cara parasit bersamaan dengan aliran air dari selokan pada awal musim penghujan. Rekolonisasi siput juga terjadi dari menetasnya telur-telur siput yang berada di habitat yang mengalami kekeringan tidak lebih dari beberapa minggu. Rekolonisasi siput di lahan sawah padi yang jauh dari pemukiman terjadi lebih belakangan dari musim penghujan. Tidak ditemukan siput terinfeksi oleh *F. gigantica* pada lahan sawah berjarak lebih dari 200 m dari pemukiman penduduk. Prevalensi tertinggi infeksi *Fasciola* ditemukan pada siput di sawah yang mendapat limpahan kotoran dari kandang ternak atau yang dipupuk dengan kotoran sapi/kerbau. Ternyata dalam satu siput hanya ditemukan infeksi oleh satu jenis larva cacing trematoda. Infeksi oleh *Echinostoma* pada siput kejadiannya paling umum.

Kata kunci: *L. rubiginosa*, infeksi trematoda, dinamika populasi.

ABSTRACT

SUHARDONO and D.B. COPEMAN. 2000. Population dynamics of *Lymnaea rubiginosa* in rice fields and its infection with larvae of trematodes. *Jurnal Ilmu Ternak dan Veteriner* 5(4): 241-249.

Field of irrigated rice paddy was the most suitable habitat as breeding site of snail *Lymnaea rubiginosa*, the intermadiate host of *Fasciola gigantica* and other trematodes. Fluctuations in the population of fresh water snail, *L. rubiginosa* in irrigated rice fields and their infection with *L. rubiginosa* and other trematodes were studied in five villages in the subdistrict of Surade, provivine of West Java. Snail were sampled based on time collection (half man hour) each site of collection. The samples of the snails were further counted and examined for the presence of larval trematodes. The result indicated that snails died during the dry season except those in persistent aquatic refuges such as streams and springs. Surviving snails recolonised rice fields near villages by passive transfer with water from refuges early in the wet season. Some recolonosation may also have resulted from haching of snail eggs deposited in habitats which had not been dried for more than a few weeks. Recolonisation with snails of further rice fields from a village occurred during the later period of the wet season. No snail infected with *F. gigantica* was found in the distance of more than 200 m from a village. Snail with the highest prevalence of infection occurred in rice fields which received effluent from a cattle pen were fertilised with bovine faeces. Each snail was only infected with one species of tramatodes. Infection with echinostone larvae was most common.

Kay words: *L. rubiginosa*, trematode infection, population dynamic.

INTRODUCTION

Lymnaea rubiginosa, an aquatic snail (VAN BENTHEM JUTTING, 1956) is the only intermediate host of *Fasciola gigantica* in Indonesia (BORAY, 1982; MUKHLIS, 1985) where it is widely distributed. This snail also serves as the intermediate host of other trematodes (BASCH and LIE, 1965; BORAY, 1982; ESTUNINGSIH, 1991). However, dual infection with two trematodes is uncommon (HAMMOND, 1956; LIE *et al.,* 1966) and a number of species of trematodes are known to be dominant antagonists of *F. gigantica* in snails (LIM and HEYNEMAN, 1972). To gain a greater understanding of the potential for control of fasciolosis through antagonism of its larvae by other trematodes in *L. rubiginosa,* a record was kept of all trematode parasites in these snails during a survey to observe the factors which influence changes in their population throughout the agricultural cycle. The biology of *L. rubiginosa* was described by WIDJAJANTI (1989) but little is known of the population dynamics of this snail in areas where production of irrigated rice is intensive. Such information is important as these are the areas where the prevalence of infection with *F. gigantica* is highest in cattle and buffaloes (EDNEY and MUCHLIS, 1962) and where such knowledge may reveal the possibility for intervention that would help control fasciolosis.

MATERIALS AND METHODS

Rainfall

Daily and monthly rainfall data were collected from a climatic station which is located in the office of the subdistrict of Surade, district of Sukabumi, province of West Java. The data is used to figure out the availability of surface water in association with the aim of study, determination of snail population dynamic.

Pilot study

A pilot study was undertaken by collecting *L. rubiginosa* from several sites in a rice-growing area (rice fields, ponds and ditches) in the village of Pasiripis, subdistrict of Surade, the province of West Java. The collected snails were then examined for the presence of larval trematodes uses a stereo microscope. Five villages within the subdistrict were chosen as the locations to study the population dynamics of this snail and its infection with trematodes.

Population dynamics of *Lymnaea rubiginosa*

The population of snail *L. rubiginosa* was monitored regularly at each location so that populations collected could be compared over time and between locations. Based on the results of the pilot study, snails were collected from three sites in each village: rice fields which were close to and remote from human settlement and rice fields adjacent to a cattle pen (pen-sawah = PS). The PS site was further divided into four or more levels. Levell was the field at the place where the dung or effluent from the pen entered the rice field. Level 2 was where water from the Level 1 field flowed into the adjoining rice field; Level 3 was where water from the Level 2 field flowed into an adjoining rice field; and so on for Level 4.

So that the number of snails collected could be meaningfully compared between locations and sites over time, a standard method of collection was used. On each occasion snails were collected for 0.5 man-hour at each site. All *L. rubiginosa* within reach by hand from the bund of the rice field were collected before moving on for five steps and collecting again, then on again, and so on. This procedure was also followed at the PS location except that only snails ≥15 mm long were collected. In this way snails were collected from about 2,000 to 5,000 m^2 of habitat at each site on each occasion. To avoid undue disruption of the snail population, three similar groups of rice fields were chosen at each location, one of which was sampled 4-weekly and the other two on alternate 8-weekly occasions. Collections from the 8 and 4-weeks sampling sites at each location were added together and divided by two to calculate the monthly collection figure for that location (Table 1).

Examination of *Lymnaea rubiginosa* for the presence of trematode larvae

Snails collected at each location were grouped into four sizes based on the length of shell: ≤10 mm, 11-15 mm, 16-20 mm and >20 mm. They were then placed in rows about 2 cm apart on a heavy clear-glass plate about 50 at a time, squashed by pressing firmly with a second heavy clear-glass plate, then examined with the aid of a dissecting microscope for the presence of trematode larvae. Cercariae other than those of *F. gigantica* were grouped as *non-Fasciola* (NF) and designated as either straight tail (ST) or forked tail (FT). Unidentified sporocysts and the early stage of rediae were designated non-identified (NI) larvae.

Table 1. Design of snail *Lymnaea rubiginosa* collection in each location within five villages every four weeks for 52 weeks in the subdsitrict ofSurade, West Java

Site of snail collection	Time collection (week)					
	0	4	8	12	….**	52
Close	(A *+B)/2	(A+C)/2	(A+B)/2	(A+C)/2	….	(A+C)/2
Remote	(D+E)/2	(D+F)/2	(D+E)/2	(D+F)/2	….	(D+F)/2
PS site level I (Ll)	(G+H)/2	(0+1)/2	(G+H)/2	(G+l)/2	….	(G+I)/2
L2	(O+H)/2	(G+I)/2	(G+H)/2	(G+I)/2	….	(0+1)/2
L3	(O+H)/2	(0+1)/2	(O+H)/2	(0+1)/2	….	(0+1)/2
L4	(O+H)/2	(0+1)/2	(O+H)/2	(0+1)/2	….	(0+1)/2

Note: * A - I were the locations for snail collection; (A+B)12 was the number of snails sampled during the time collection
** Continuing Sampling 4 - weekly up to 52 weeks

RESULTS

Rainfall

Data on four-weekly rainfall during the study period are shown in Figure 1. The data were supplied by the weather office of the subdistrict of Surade which is located about the middle of the study area. The average annual rainfall was 2,739 mm from 1982 to 1991.

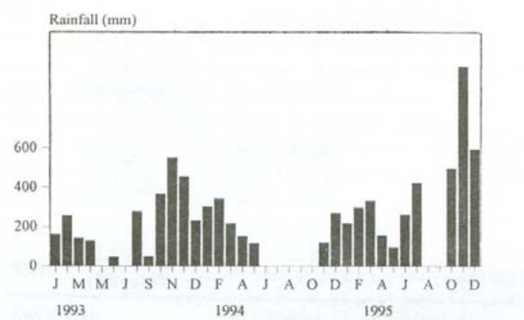

Figure 1. Four-weekly rainfall (mm) between 1993 and 1995 in the subdistrict of Surade, West Java

Rainfall during 1992 and 1993 was higher than average, being 4,063 mm and 3,121 mm respectively. However, in 1994 the rainfall was less than average at 1,527 mm. The dry season in 1994 was longer than in 1993, extending from May to October 1994. In November 1994 too, compared to the same period in 1993, the rainfall was much lower. The earlier and more prolonged dry season in 1994 than usual caused the second irrigated rice crop to fail that year and with it the main habitat of *L. rubiginosa.*

Pilot study

Results of the pilot study, which commenced in early April 1993, are shown in Tables 2 and 3. The results indicated that the prevalence of infection with larval trematodes and the size of the population of *L. rubiginosa* were inversely related to the distance trom the village.

Infection with *F. gigantica* was not detected in snails ≤10 mm long and most infected snails were 10-20 mm long. The highest prevalence of infection with *F. gigantica* was in snails in rice fields adjacent to a cattle pen (PS site). Infection decreased progressively in the snails in the successive rice fields into which water from the PS site flowed. Prevalence of infection with non-F. *gigantica* trematodes was higher than the prevalence of infection with *F. gigantica;* the highest was in the PS site.

Based on the results of this pilot study, further surveys were planned in two categories of rice field, one close to the village «100 m) and the other remote from the village (>500 m). Investigations started in May 1993.

Population dynamics of *Lymnaea rubiginosa*

Rice fields <100 m trom villages showed relatively little fluctuation in the number of *L. rubiginosa* found at each collection (Figures 2, 3 and 4) except dUring the dry season when collections were lower and no snails were found in some villages during July, August and September. More than 95% of the snail habitats (mainly rice fields) became desiccated during that period and the snails died. During the dry season most snails collected were adult (> 15 mm in length). The surviving snails during those periods were mostly found in residual springs and drains from the springs, and in streams or rivers in which, at that time, the current was very gentle and just perfect as a snail habitat. Once the rainy season started the population of *L. rubiginosa* increased substantially. The surviving snails in the refuges moved with the flow of water to recolonise the newly prepared rice fields, water channels etc.

During November when the first seasonal crop of rice was about 6 to 8 weeks trom harvest, most of the snails were less than 15 mm long but in the following months those greater than 15 mm were predominant. The population was maintained in rice fields at a high level throughout the wet season and for a further few months into the dry season.

During the early dry season there was no sign of substantial propagation of snails.

Results of collections of snails from rice fields about 500 m from Kadaleman and Pasiripis are presented in Figure 5. The population of snails fluctuated with availability of water. From August to November no snails were found despite the commencement of the rainy season. From late December onwards, however, the population increased and reached its peak between March-April. The pattern of increase and decrease of the snail population followed the pattern of increase and decrease of rainfall.

Infection of *Lymnaea rubiginosa* with trematode larvae

Figures of mean prevalence of infection with *F. gigantica* in the *L. rubiginosa* from rice fields were 1.03%, 0.38% and 0% in the PS site, <200 m and >500 m from kampongs respectively. In comparison, respective prevalence proportions of infection with the *non-Fasciola* trematodes were 11.14%, 11.98% and

Table 2. Prevalence of cercariae of *Fasciola gigantica* and other trematodes in *Lymnaea rubiginosa* collected from rice fields or a ditch in the village ofPasiripis, relative to distance from the village and size ofthe snail

Type of cercaria	Number of *Lymnaea rubiginosa*				Tota (%)
	≤10 mm	10-15 mm	16-20 mm	≥21 mm	
<u>Ditch</u>					
ST	0	0	1	0	1(0.2)
Negative	26	140	71	238	475(99.8)
Rice fields <100 m from village					
Fg	0	4	6	0	10(0.2)
ST	0	20	58	9	87(1.7)
FT	0	1	1	0	2(0.04)
Negative	225	4,176	589	61	5,051(98)
Rice fields 200-500 m from kampong					
ST	0	0	3	3	6(1.5)
Negative	156	149	87	11	403(98.5)
Rice fields >500 m from kampong					
ST	0	0	2	0	2(1.1)
Negative	58	45	85	0	188(98.9)
<u>Total</u>					
Fg	0	4	6	0	10 (0.2)
ST	0	20	64	12	96 (1.5)
FT	0	1	1	0	2 (0.03
Negative	465	4,510	832	310	6,117(98.3)

ST: straight-tail cercariae other than *F. gigantica*
FT: forked tail cercariae
Fg: *Fasciola gigantica* cercariae

Table 3. : Prevalence of cercariae of *Fasciola gigantica* (Fg) and those of other species with a straight-tail (ST) or forked tail (FT) in *Lymnaea rubiginosa** collected from an irrigated rice field adjacent to a cattle pen at Pasiripis

Number and percentage of snails	Type of cercaria			Cercariae not present
	Fg	ST	FT	
Number of snails	62	2{}8	1	595
Percentage infected	7.2	24.0		68.7

Note * Snails were not grouped according to size but more than 90% of them were 15 to 20 mm long

4.29%. Occasionally gymnocephalic cercariae were found infecting *L. rubiginosa*. A free living trematode and *Chaetogaster limnaei* were commonly observed attached to the body of the snail.

Infection with Fasciola gigantica in Lymnaea rubiginosa

Data on prevalence of infection of *L. rubiginosa* with *F. gigantica* are presented in Figures 2, 3 and 6.

The highest prevalence was observed during the rainy season in May and October 1993 and February 1994. The higher infection of snails with *F. gigantica* in May 1993 compared with the same period in 1994 might be related to the rainfall in 1992/1993 which was more than normal. During the driest period of the dry season,

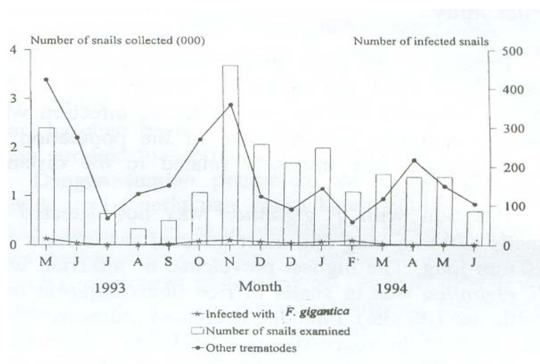

Figure 2. Total number of Lymnaea rubiginosa collected each 4 weeks trom rice fields <200 m from 5 villages and number infected with Fasciola gigantica or other species of trematode

July and August, no snail was found infected with *F.*

gigantica. No snails were infected with *F. gigantica* trom rice fields remote (>200 m) trom villages or trom fields two removed but receiving irrigation water trom fields adjacent to a cattle pen (Figure 6).

Infection of Lymnaea rubiginosa with non-Fasciola gigantica trematodes

The proportion of *L. rubiginosa* infected with straight-tail cercariae (10.7%) was much higher than that infected with forked-tail cercariae (0.26%).The results are depicted in Table 2. In general higher proportions of infection with non-F. *gigantica* trematodes were recorded trom Citanglar and Kadaleman than trom the other three villages. The prevalence showed little seasonal fluctuation but the peak of infection occmed during the early wet season (April). However, this pattern was not clear in the villages of Pasiripis and Buniwangi. In Pasiripis the peak infection occurred in the early dry season and was low at other times. In Buniwangi, in contrast, prevalence of infection increased during early wet season, reached a peak in January then decreased again.

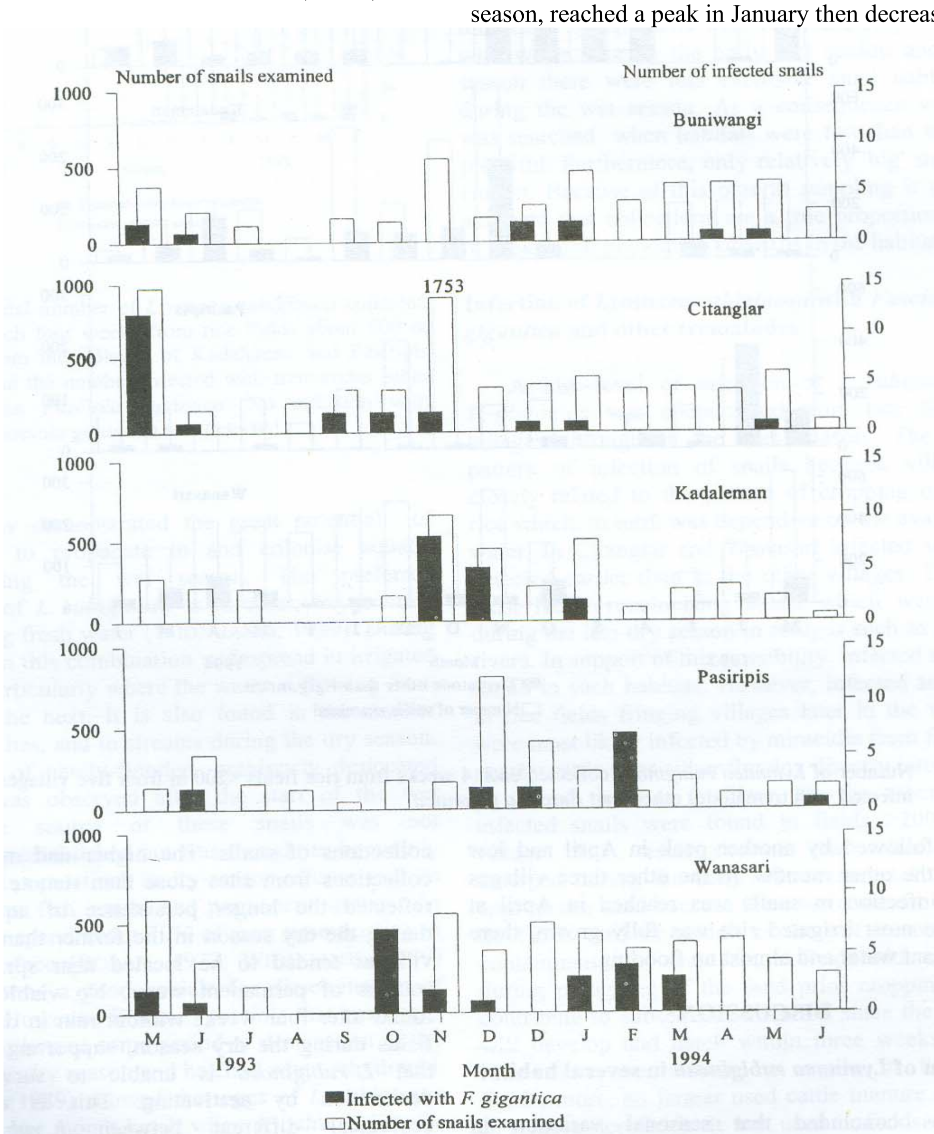

Figure 3.: Number of *Lymnaea rubiginosa* collected each 4 weeks from rice fields <200 m from five villages, and numbers infected with *Fasciola gigantica*

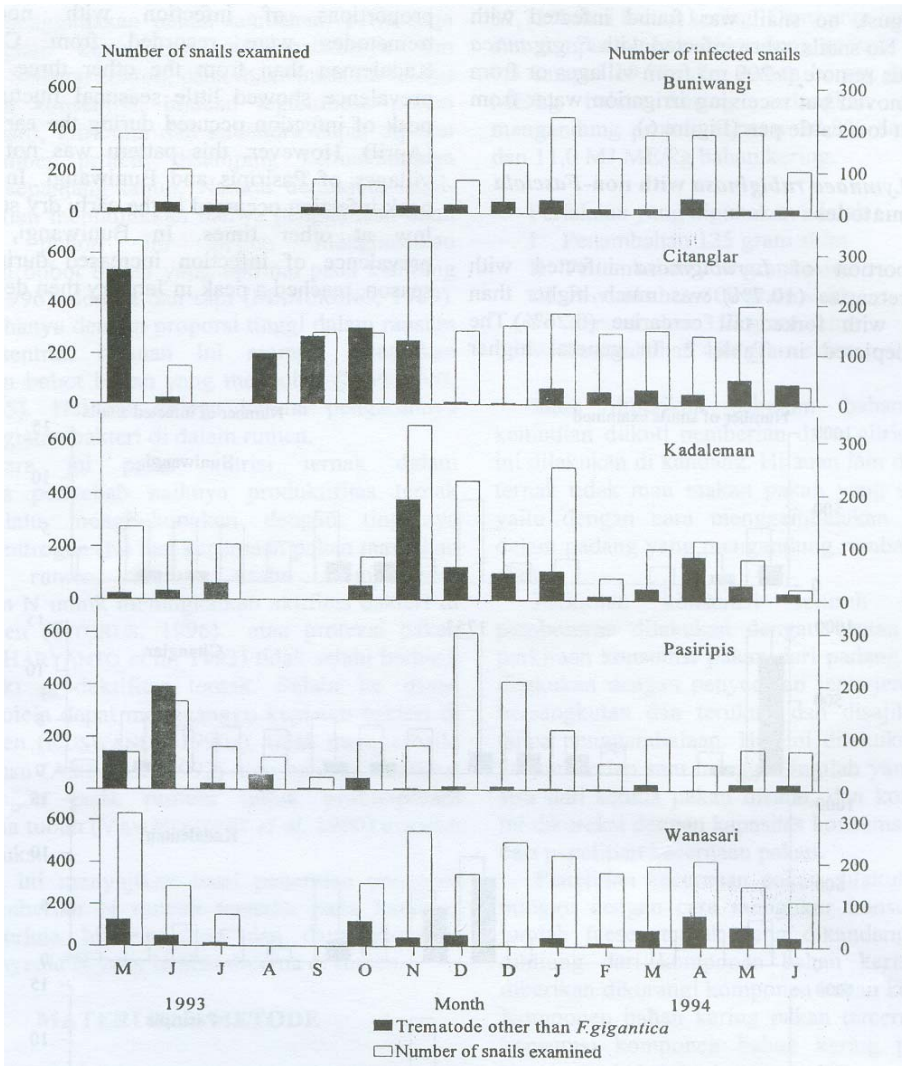

Figure 4.: Number of *Lymnaea rubiginosa* collected each 4 weeks from rice fields <200 m from five villages, and numbers infected with trematodes other than *Fasciola gigantica*

This was followed by another peak in April and low levels for the other months. In the other three villages the peak infection in snails was reached in April at which time most irrigated rice was fully grown, there was abundant water and almost no flooding.

DISCUSSION

Population of *Lymnaea rubiginosa* in several habitat

It was concluded that seasonal variation in availability of suitable aquatic habitats for *L. rubiginosa,* rather than other climatic factors, was the main determinant of the seasonal fluctuations in collections of snails. The higher and more persistent collections from sites close than remote from villages reflected the longer persistence of aquatic habitats during the dry season in the former than the latter, as villages tended to be located near springs or other sources of permanent water. No viable snails were found after four weeks without rain in dry fallow rice fields during the dry season, supporting a conclusion that *L. rubiginosa* is unable to survive seasonal desiccation by aestivating. This is an important ecological different between *L. rubiginosa* and lymnaeid snails which are the intermediate host of *F. hepatica* which can aestivate during drought. BORAY (1973) reported that *L. tomentosa* aestivated for months in dry mud in Australia and in the high land of Papua New Guinea OWEN (1989) observed aestivation in *L. viridis*.

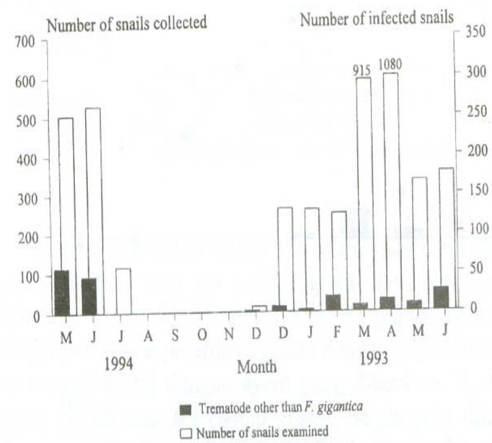

Figure 5. Total number of *Lymnaea rubiginosa* collected each four weeks from rice fields about 500 m from the villages of Kadaleman and Pasiripis and the number infected with trematodes other than *Fasciola gigantica*. No infection with *Fasciola gigantica* was detected

This study demonstrated the great potential of *L. rubiginosa* to propagate in and colonise aquatic habitats during the wet season. The preferred environment of *L. rubiginosa* is in clear, oxygenated, gently flowing fresh water (WIDJAJANTI, 1989). During . the wet season this combination widespread in irrigated rice fields, particularly where the water is flowing from one plot to the next. It is also found in the smaller irrigation ditches, and in streams during the dry season. Colonization of newly-flooded, previously desiccated rice fields was observed after the start of the wet season. The source of these snails was not unequivocally established but was thought to be mainly from residual populations in dry-season refuges such as rivers, streams, fish ponds, and permanent springs. As *L. rubiginosa* spend about 70% of their time floating at the water surface (BORAY, 1973; WIDJAJANTI, 1989) flowing water is a good vehicle for dissemination of these snails. However, it is also possible that snail eggs are able to withstand some period of desiccation in dry fields over the dry season and hatched when rehydrated. WIDJAJANTI (1989) showed that eggs of *L. rubiginosa* kept dry for one month hatch when rehydrated but she did not determine over what period dry eggs would remain viable. It is doubtful that snail eggs survived some months of desiccation in the rice fields remote from villages as these fields were recolonised with snails later after the onset of the wet season than fields surrounding villages where the period of desiccation was generally less prolonged. Thus, early recolonisation of fields close to villages may have been from hatching residual snail eggs and with snails dispersed from dry season refuges with irrigation water whereas more remote fields were recolonised with snails passively dispersed in the irrigation water.

One the disadvantage of the method of collecting snails based on the timed collection which was used in this study is that snails were collected only from fields with water. During the early wet season and the dry season there were less extensive snail habitats than during the wet season. As a consequence wider area was searched when habitats were few than when they plentiful. Furthermore, only relatively ‘big’ snails were caught. Because of this bias in sampling it cannot be assumed that collections are a true proportional image of the overall population of snails in the habitat.

Infection of *Lymnaea rubiginosa* with *Fasciola gigantica* and other trematodes

A low level of infection of *L. rubiginosa* with *F. gigantica* was encountered from rice fields near villages throughout the wet season. The different pattern of infection of snails between villages was closely related to the pattern of cropping of irrigated rice which, in turn, was dependent on the availability of water. In Citanglar and Wanasari infected snails were detected earlier than in the other villages. These were most likely recolonising snails which were infected during the late dry season in refuges such as streams or rivers. In support of this possibility, infected snails were found in such habitats. However, infected snails found in rice fields fringing villages later in the wet season were most likely infected by miracidia from faeces from nearby cattle pens either flowing directly into rice fields or placed there as fertilizer. On the other hand, no infected snails were found in fields >200m from a village. This result showed that miracidia which emerged during the early wet season did not find an appropriate snail because there were almost no snails in the fields until the middle of the wet season. Thus, the contamination of such remote fields with cattle faeces during ploughing of the land prior cropping does not contribute to subsequent infection since the fluke eggs will develop and hatch within three weeks, at which time there are almost no snails in these areas. Furthermore, no farmer used cattle manure as fertilizer in remote rice fields. It was used in fields close to the cattle pen or stored and used to fertilize dry-land crops.

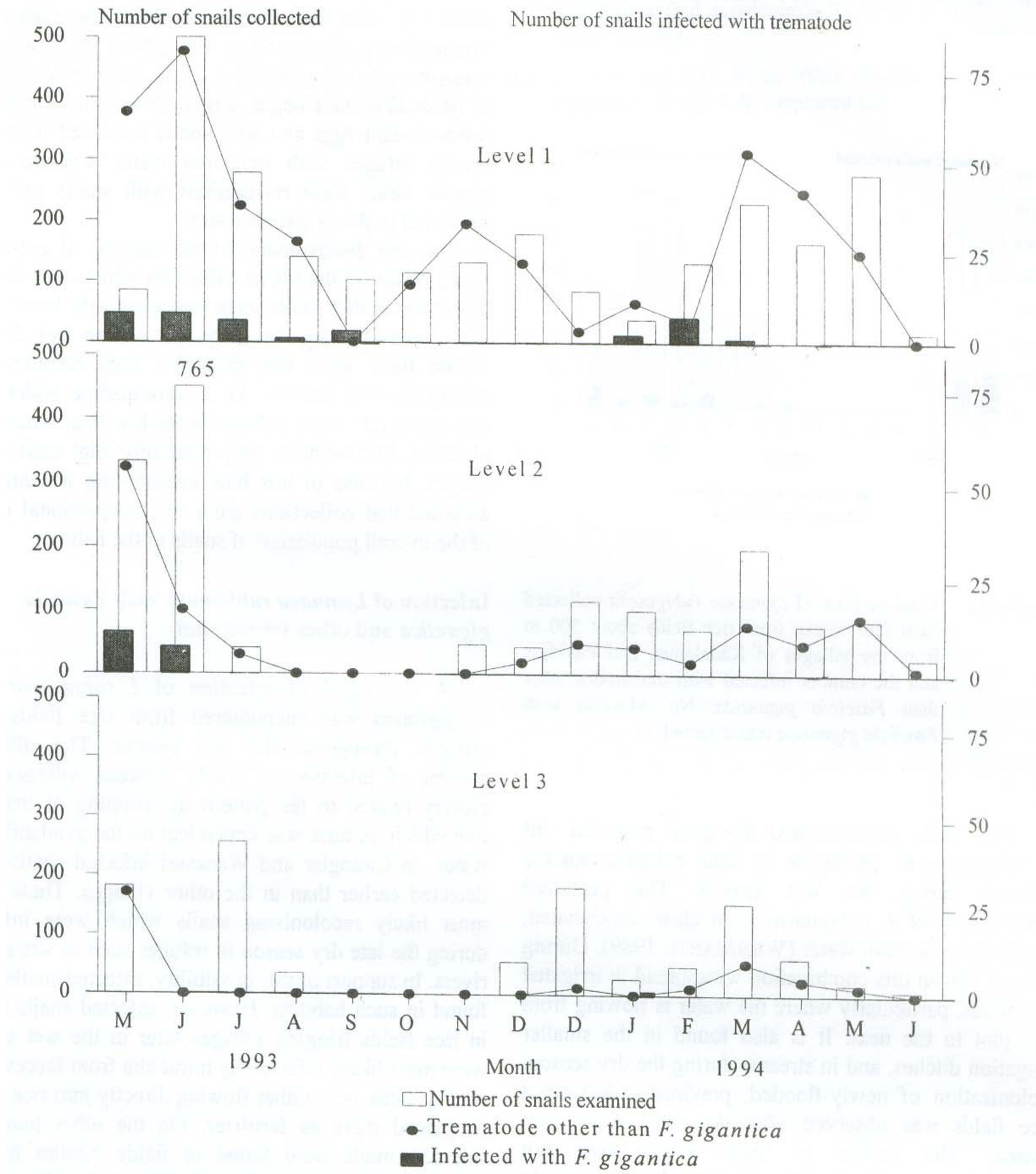

Figure 6.: Fluctuations in the number of *Lymnaea rubiginosa* and in their prevalence of infection with *Fasciola gigantica* and other trematodes in three levels of rice field in tandem, the first of which was adjacent to a cattle pen

SUHARDONO *et al.* (1989) reported that prevalence of infection rate with *F. gigantica* in *L. rubiginosa* collected trom the some region as this study was 0.9%. This figure is in agreement with findings in this study and similar to that of CHOWDHURY *et al.* (1994) who reported 0.31% infection in *L.auricularia* var *rufescens* with gymnocephalic cercariae and the peak of infection between July-August during mid monsoon season. WAMAE and CHERIUYOT (1990), on the other hand, found 31.4% prevalence in *L. natalensis* in Kenya. However, such figures are not very meaningful in epidemiological terms unless supported by additional data on determinants and risk factors such as extent a nature of the habitat trom which the snails were collected and access of animals to the habitat.

The relatively high prevalence of infection with *F. gigantica* in *1. rubiginosa* in rice fields which received faecal effluent direct trom a cattle pen (PS fields) was anticipated. However, the significant drop in prevalence of infection in snails in the adjacent rice field, which was irrigated by water flowing from the PS field (Figure 6) demonstrated that miracidia and infected snails were not widely dispersed with the gentle flow of water through rice fields. This conclusion is also supported by the slow colonization of rice fields by snails remote from villages where peak numbers are not reached until about the middle of the wet season, which was two to three months after numbers peaked in rice fields near villages.

Parasites other than *F. gigantica* were also found in *1. rubiginosa.* Echinostome cercariae were dominant in this study. Echinostomes are mainly parasites of water birds. In this study they probably came from infected kampong chickens, geese, domestic ducks, or wild water birds. Prevalence of infection of *1. rubiginosa* with *non-Fasciola* trematode larvae was higher than infection with *F. gigantica.* No snail was found infected with more than one species of trematode. Similar findings were reported by SCHILLHORN VAN VEEN (1980), WAMAE and CHERIUYOT (1990) and ESTUNINGSIH (1991). Fork-tail cercariae were present in 5.8% of snails examined and prevalence of nonencysting straight-tail cercariae was 9.7%. The common occurrence of C. *limnaei* in snails in this study is similar to the findings of KHALIL (1961).

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