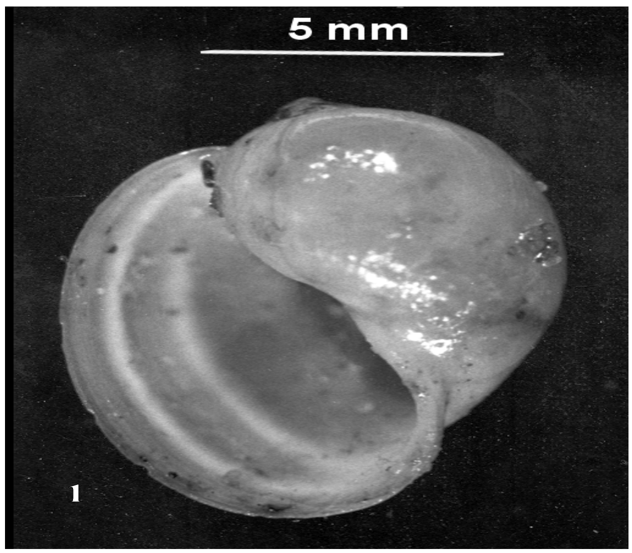
COSEWIC
Assessment and Status Report

on the

Lake Winnipeg Physa
Physa sp.

in Canada



ENDANGERED
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215
Fax: (819) 994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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Lake Winnipeg Physa — supplied by the author.

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COSEWIC
Assessment Summary

Assessment Summary – November 2002

Common name
Lake Winnipeg physa

Scientific name
Physa sp.

Status
Endangered

Reason for designation
Populations of this Canadian endemic are confined to Lake Winnipeg, where there are continuing declines in extent of occurrence, area of occupancy and extent of habitat due to habitat alteration, human disturbance and quality of habitat. Evidence suggests that nutrients and contaminants from sewage lagoons, industries, waste storage facilities and/or landfills are contributing to the declines.

Occurrence
Manitoba

Status history
Designated Endangered in November 2002. Assessment based on a new status report.

COSEWIC
Executive Summary

Lake Winnipeg Physa
Physa sp.

Species information

The shell of *Physa* sp. is thin, inflated, generally less than 11 mm long, with a depressed spire and dull surface. The shell width:length ratio exceeds 0.70, and the aperture:shell length ratio is greater than 0.80. The animal is light grey in color, with long tentacles.

Distribution

The distribution is limited to Lake Winnipeg.

Habitat

This snail is found on algae-coated rocks at a depth of less than 1 metre, in exposed, high-energy areas.

Biology

Little is known regarding the biology of this mollusc.

Population sizes and trends

Five subpopulations were identified in 2001. Those previously documented at another two sites were not found in 2001, suggesting a decline.

Limiting factors and threats

Pollution, particularly nutrient influx from cottage developments, urban centres and livestock operations, and habitat disruption due to recreational use and shoreline modification are primary threats. Other concerns include influx of nutrients and silt from intensive logging and increased shoreline erosion due to water-level regulation.

Special significance of the species

The presence of an endemic gastropod in Lake Winnipeg is of scientific and ecological interest. While many molluscs have shown a marked decline in southern Manitoba during the past two decades, this particular snail may be at risk even before it has been studied.

Existing protection or other status designations

None of the sites where this snail is presently known to occur are protected.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.
** Formerly described as “Not In Any Category”, or “No Designation Required.”
*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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2002

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SPECIES INFORMATION

Name and classification

Phylum	Mollusca
Class	Gastropoda
Superfamily	Physacea
Family	Physidae

The systematics of the Physidae have been in disarray for more than a century. The large number of intergrades and ecological morphs has contributed to much confusion and misidentification, with the result that many literature reports may be unreliable. According to Te (1973), both shell and radular characters can be of limited systematic value within this family for some species. Penial sheath morphologies have been shown to be of greater use, especially for species groupings, and can be correlated with other characters, such as types of shell spires (Te, 1974). However, in practical terms, the latter author has still relied on general shell shape in his diagnostic key for Michigan Physidae (Te, 1975).

Comparisons of gene sequences have proven to be useful indicators of phylogenetic relationships. Molecular systematics provide the most accurate assessments of taxonomic status, and such methods are particularly effective in groups which are prone to homoplasy. Some molecular work has been undertaken for lymnaeids (Remigio, in press) and for three western Canadian physids (Remigio et al., 2001). A study of allozymes in selected species of *Physa* allowed for some interspecific differentiation (Liu, 1993). However, a comprehensive molecular survey of the Physidae has yet to be undertaken.

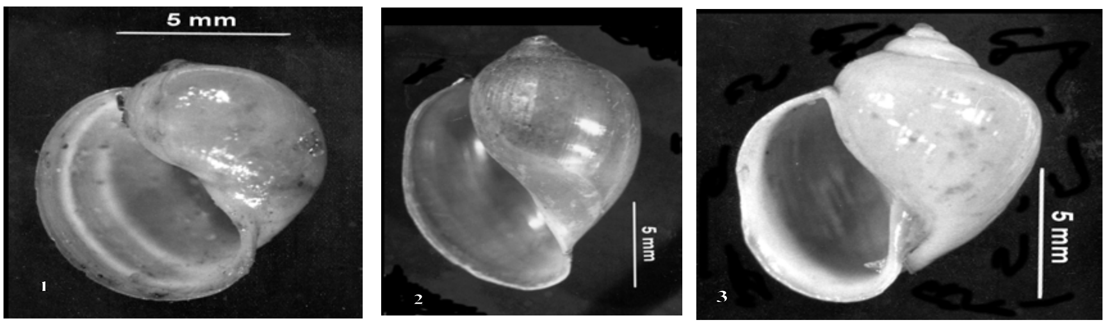
The use of *Physella* and *Physodon* as generic designations for the North American physids has been contested by Clench (1930), and the ensuing confusion in the use of these names has prompted Te (1975) to recommend that "the use of *Physella* and *Physodon* in place of *Physa* should be avoided", at least until a rigorous examination has been made of the standing of these groupings. However, *Physella* as a generic designation has subsequently been used by Te and Clarke (1985), Liu (1993) and Remigio et al. (2001). In the present document, all species are referred to under the generic designation of *Physa* (*sensu lato*).

Three described species of *Physa* occur within the watershed of Lake Winnipeg: *P. gyrina* (Tadpole Snail), *P. integra* (Solid Lake Physa) and *P. jennessi skinneri* (Blunt Prairie Physa). A fourth, apparently undescribed, taxon is the subject of the present status report. It is hereafter referred to as *Physa* sp. (Lake Winnipeg Physa).

Description

The Lake Winnipeg Physa (Fig. 1) appears to be quite distinct morphologically from both *P. gyrina* (Fig. 2) and *P. integra* (Fig. 3). The shell is small (usually <11 mm long), fragile, globose, with a depressed spire and thin lip. Other North American species with globose shells that are superficially similar include: *P. globosa* Haldeman 1841 (found in Kentucky, Ohio and Tennessee), and *P. utahensis* (Wyoming, Colorado and Utah) (see Burch, 1989).

Physa integra is distinguished from *P. gyrina* by its thick robust shell, shouldered whorls, more acute spire, incised sutures, and several thickened white varices, with a particularly heavy white callus in the outer lip (LaRocque 1968, Clampitt 1970). Clarke (1973, 1981) did not include Manitoba in his reported range for *P. integra*, placing it to the east in the "Great Lakes-St. Lawrence and Ohio-Mississippi systems." However, Mozley (1938 *in* LaRocque 1968) reported it from "Muckle Creek, near Clandeboye" (a wetland at the south end of Lake Winnipeg), and subsequent surveys by Pip (1978, 2000) found this physid at a number of locations in southern Manitoba.



Figures 1-3. Lake Winnipeg physids. 1: *Physa* sp., 2: *Physa gyrina*, 3: *Physa integra*.

Physa jennessi skinneri does not occur in the main body of Lake Winnipeg and favours quiet backwaters. In the present study it was found only at site 9, a protected boat channel behind a marina. This species is readily distinguished by its blunt apex, transparency, and flattened body whorl.

The shell of the Lake Winnipeg Physa has a dull, often pitted surface, and fresh shells are bluish-grey in color. This contrasts with the smooth and glossy, golden or light brown shells of Lake Winnipeg specimens of *P. gyrina*. Rest marks in the latter species are marked by white axial thickenings, usually bordered by a burgundy stripe. Such colored stripes are absent in both *P. integra* and *Physa* sp.

Physa ancillaria Say 1825 may often have a somewhat globose shape; however, the outer lip is more compressed and flattened than in *Physa* sp. Mozley (1938 *in* LaRocque 1968) cited *P. ancillaria* in Manitoba from Indian Bay in Shoal Lake, near the Ontario boundary. Surveys by Pip (unpublished data) in Shoal Lake during 1983-86 failed to find this physid; all of the lots collected from this lake were *P. gyrina*. LaRocque (1968) has thought *P. ancillaria* to be a synonym of *P. heterostropha*. The latter has not been reported from Manitoba.

Similarly *P. sayii* Tappan 1838 may have inflated ecological morphs. However, the standing of this name is currently ambiguous, and intermediate forms between *P. gyrina* and *P. sayii* have been reported (Te, 1975). A summary of aperture:shell length ratios is given in Table I (from LaRocque 1968), while Te's (1975) comparison of shell characters for the relevant physid species for "typical" Michigan lots is listed in Appendix I.

Table I. Aperture:shell length ratios for physids reported by LaRocque (1968).

Species	Aperture:shell length ratio
Physa ancillaria	0.7-0.8
P. gyrina	0.5-0.7
P. integra	0.6-0.7

A summary of shell ratios is given in Table II for Lake Winnipeg populations of *P. gyrina, P. integra* and *Physa* sp. The Lake Winnipeg Physa is consistently wider in proportion to total shell length, and shows the highest mean ratio of aperture to shell length. Duncan's multiple range test (Zar, 1974) showed that width:length ratios for *Physa* sp. were significantly higher than those of both *P. gyrina* and *P. integra* ($F=12.2$, $p<0.0002$). For aperture:shell length ratios, the Bartlett-Box F test for homogeneity of variances indicated that variances among species were significantly different for this parameter; therefore the nonparametric Kruskal-Wallis test was applied (Zar, 1974). The result indicated that the aperture:shell length ratio for *P. gyrina* was significantly different from those of both *P. integra* and *Physa* sp. (Chi-square=6.85, $p=0.03$). Thus the relative shell width appears to be the best, but not sole, differentiating character.

The living animal of *Physa* sp. is light grey in colour, sparsely peppered with black spots. *Physa gyrina,* in contrast, has a dark, almost black body colour and shorter tentacles. The periostracum of both species is black in colour.

The holotype has been deposited in the Canadian Museum of Nature as *Physa winnipegensis*, catalogue No. CMNML 093695.

Table II. Mean shell measurement ratios (± S.E.) for Lake Winnipeg physids.

Species	Shell width:length	Aperture length:shell length
Physa gyrina	0.61 (± 0.02)	0.76 (± 0.01)
Physa integra	0.67 (± 0.02)	0.74 (± 0.03)
Physa sp.	0.72 (± 0.01)	0.81 (± 0.01)

Table III. Relative frequencies (%) of the three Lake Winnipeg physids at sites where *Physa* sp. was found.

Site no.	N (total)	*P. gyrina*	*P. integra*	*Physa* sp.
6	5	40		60
21	24	83		17
28	28	21	37	42
57	11		82	18
77	34	59	24	17

DISTRIBUTION

Because the species has not been formally described, no published information is available regarding its distribution. However, extensive surveys by Pip (1978, 1985, 1992, 2000, and unpublished data) of nearly 1000 sites in Manitoba, Ontario, Saskatchewan, North Dakota and Minnesota found this *Physa* only in Lake Winnipeg. None of the adjacent lakes or tributaries of Lake Winnipeg have yielded this snail. Thus it appears to be endemic to the lake.

While 90 Lake Winnipeg stations were examined in 2001 (Fig. 4), *Physa* sp. was found only at 5 locations (Fig. 5). At each station, rocks and submerged objects up to 1 metre deep were examined, and collections of beach drift were made. Any living snails were returned immediately to their habitat. The sites were visited during May to August.

Distribution of *Physa* sp. appears to be very patchy and discontinuous within the lake, with occurrences on both east and west sides of the basin. Indeed, distribution of all mollusc communities in the lake is erratic and appears to be largely dependent on the stability of bottom substrates. Very few molluscs occur in sandy, exposed areas, unless rooted submerged vegetation is present. The mollusc communities in Lake Winnipeg favour shallow, near-shore areas. However, in the present study, no molluscs were found at 37 of the 90 stations examined.

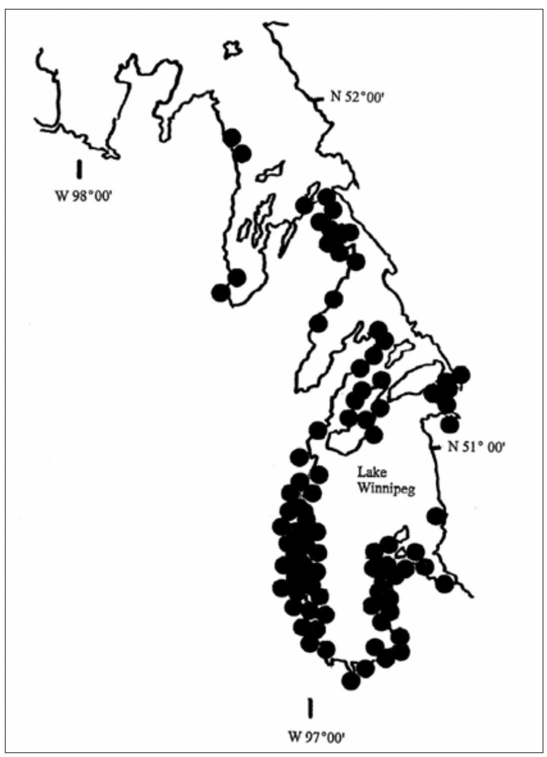


Figure 4. Distribution of Lake Winnipeg sites surveyed in 2001.

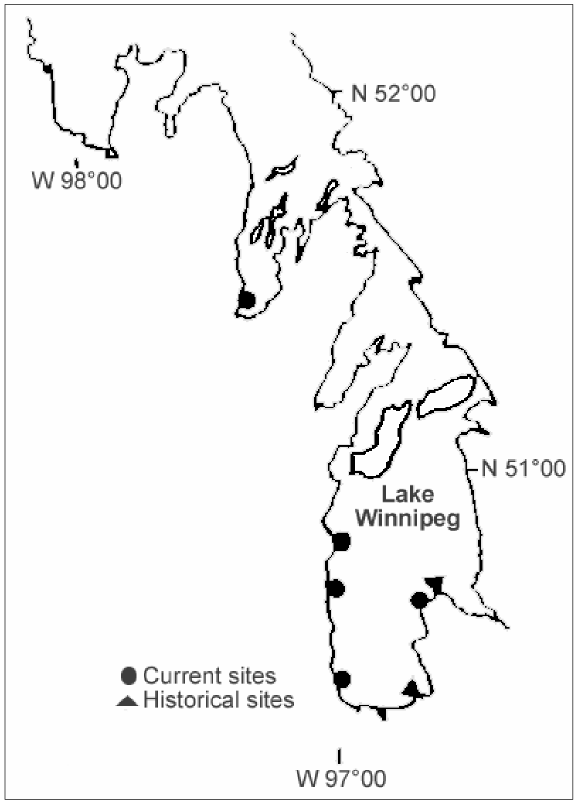


Figure 5. Known distribution of *Physa* sp.

Bottom sediment samples collected from deeper offshore regions are typically devoid of living molluscs (Pip, unpublished data). Lake Winnipeg may be generally characterized as a depauperate lake with respect to molluscs, compared with the much more productive and shallower Lake Manitoba (maximum depth 6.3 m, compared with 61 m for Lake Winnipeg).

Since the large lakes in Manitoba are remnants of glacial Lake Agassiz, the question arises why this *Physa* is not found in any other of these lakes. This form may have arisen (possibly from *P. integra*) in the approximately 12,000 years since the glacier uncovered the south basins of Lakes Winnipeg and Manitoba (Teller and Last, 1981), and Lake Winnipeg became isolated. Physids may speciate rapidly: for example, Remigio et al. (2001) found molecular evidence to suggest that *P. johnsoni* probably separated from *P. gyrina* in the Banff area approximately 10,000 years ago. Conditions in North America appear to be particularly conducive to speciation in this family, as the number of physid species is highest on this continent.

Alternately, this mollusc may have once had a wider distribution and become extinct in all other remnants of Lake Agassiz except for the deepest basin. Since deglaciation, Lake Winnipeg has provided the most stable environment, while Lake Manitoba has undergone great fluctuations in size and water chemistry, including periods when most of the basin was dry (Teller and Last, 1981). These fluctuations are reflected in the composition of the mollusc communities in the sediment record of Lake Manitoba (Pip, 1990). However, a study of Lake Manitoba sediment cores spanning the entire history of this lake since deglaciation failed to find any *Physa* species, even though *P. gyrina* does presently occur in that lake. This is likely due to the fact that shells of this fragile genus are not well preserved in bottom sediments (Pip, 1988b).

The waters of Lake Winnipeg also have retained the lowest total dissolved solids (TDS) concentrations of the large central Manitoba lakes. While the mean TDS value for the 90 stations sampled in 2001 in Lake Winnipeg was 164 mg/L (range 40 - 370 mg/L), TDS levels in Lake Manitoba may reach 3200 mg/L (Last, 1984; Pip, unpublished data). Thus water chemistry conditions may be unsuitable for this *Physa* in the other lakes.

Within Lake Winnipeg, *Physa* sp. was found on both east and west sides of the basin. Water quality on the east side of the south basin is significantly lower in TDS (east 138 mg/L $\pm$ 12 S.E. vs. west 176 mg/L $\pm$ 8 S.E.; $t = 2.63$, $p=0.01$) (Pip, in preparation). This difference is due to the Winnipeg River, which accounts for approximately 40% of the total water flowing into Lake Winnipeg, originates in the Lake of the Woods and drains a watershed that is underlain by Precambrian Shield igneous and metamorphic rock (Jones and Armstrong, 2001). The west side of the lake is underlain by Ordovician limestone. Thus the water from the Winnipeg River and smaller streams along the east side has a dilution effect on the eastern part of the basin.

HABITAT

Habitat requirements

Physa gyrina is the most abundant physid in south and central Manitoba, as well as in Lake Winnipeg. In the present study, this species was found at 23 of the 90 stations (Table IV). It is highly adaptable, can occupy a wide variety of habitats, and particularly favours low energy areas with high macrophyte species richness (Pip, 1988a, 1992). In quiet habitats, its size may exceed 25 mm. However, in much of Lake Winnipeg the turbulence, low organic matter and sparse submerged vegetation provide less optimal environments for this species, and there it is much smaller in size (<15 mm).

Physa integra is less common and was found at 7 of the 90 stations. In Lake Winnipeg, *P. integra* commonly coexists in the same communities with *P. gyrina*. These two species usually occurred together in the lake (sites 15, 18, 28, 41, 61, 77), and this positive association was confirmed ($p<<0.05$) by Chi-square tests for association with Yates' correction for continuity (Sokal and Rohlf, 1981).

Table IV. Number of co-occurrences of *Physa* sp. with other mollusc species, and the total number of sites at which each species was recorded.

SPECIES	No. of co-occurrences with *Physa* sp.	Total number of occurrences (max. 90)
Valvata tricarinata	2	13
V. sincera	0	2
Amnicola limosa	0	6
Probythinella lacustris	1	7
Cincinnatia cincinnatiensis	2	5
Lymnaea stagnalis	1	5
Stagnicola elodes	2	12
S. catascopium	0	3
Fossaria modicella	1	3
F. exigua	1	1
F. dalli	2	3
F. parva	0	1
F. decampi	0	1
Pseudosuccinea columella	0	3 (subfossil)
Planorbula armigera	1	14
Helisoma anceps	1	4
H. campanulatum	0	1
H. trivolvis	2	12 (deformed at site 57)
Gyraulus parvus	1	8
G. circumstriatus	0	9
G. deflectus	0	3
Aplexa hypnorum	1	4
Physa gyrina	5	23
P. integra	3	7
P. jennessi skinneri	0	1
***Physa* sp.**	--	5
Pyganodon grandis	4	20
Lampsilis radiata siliquoidea	4	29
L. ventricosa	0	2
Strophitus rugosus	1	8
Proptera alata	0	2
Sphaerium nitidum	0	1
S. rhomboideum	0	4
S. lacustre	4	10
S. striatinum	0	1
Pisidium spp.	0	1
Total 26 gastropod spp. and 11 bivalve taxa		Total 90 sites studied Molluscs found at 52 sites

The Lake Winnipeg Physa is a lacustrine phycophagous snail which is found primarily on medium to large algae-coated submerged rocks at a depth of less than 1 metre, in open wave-swept areas (Fig. 6). All of the stations where this snail has been recorded (in 2001 and previously) were exposed beaches. The bottom substrate at all but one of the sites was a mixture of sand, gravel and rocks. The exception (at Fisher

Bay) was a beach of limestone shingle. Despite the rigorous environment, the shell of this species is very thin. Chi-square tests showed that this snail was significantly ($p<<0.05$) positively associated with both *P. gyrina* and *P. integra* in the lake. Thus, in Lake Winnipeg, the three species of *Physa* occupy similar environments

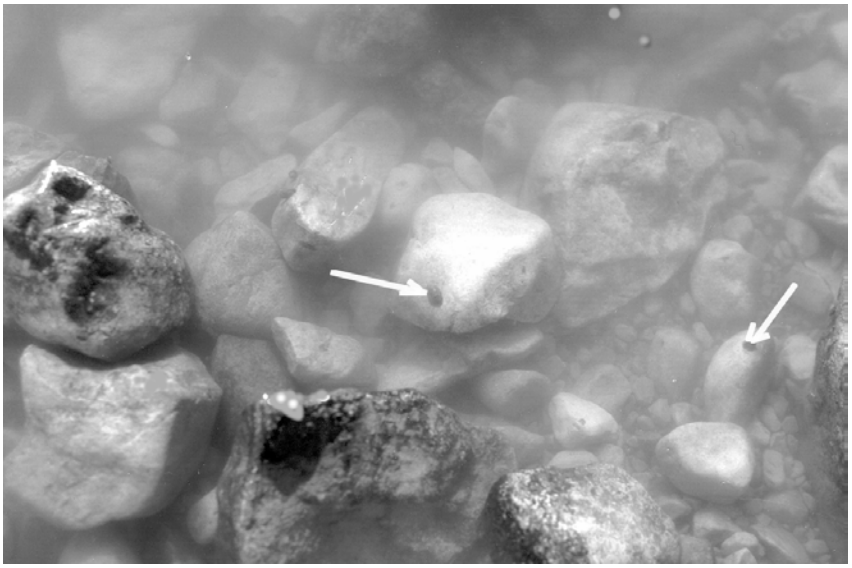


Figure 6. *Physa* sp. *in situ* in Lake Winnipeg.

Relative frequencies of the three *Physa* species at the five stations where *Physa* sp. was found in 2001 are given in Table III. While *Physa* sp. often occurred with either *P. gyrina* or *P. integra*, or both, it never occurred as the sole *Physa* species. In contrast, *P. gyrina* was the only physid found at sites 1, 14, 32, 39, 50, 58, 60, 62, 63, 66, 67, 83, 84, 86.

Offshore benthic samples collected throughout the north and south basins of Lake Winnipeg in 1999 by the Department of Fisheries and Oceans using the Coast Guard vessel NAMAO contained very few molluscs, and none of these were *Physa* sp. (Pip, unpublished). This gastropod therefore appears to be limited to nearshore habitats.

The number of co-occurrences of *Physa* sp. with other mollusc species is given in Table IV, together with the total number of occurrences of each species among the 90 sites studied. Mean gastropod species richness at the sites where *Physa* sp. occurred was 6.2, compared with the average gastropod species richness of 3.9 for sites where gastropods were found. Thus the Lake Winnipeg *Physa* tended to occur within richer communities.

Chi-square tests found that *Physa* sp. was significantly ($p<0.05$) more frequently found at sites where *Cincinnatia cincinnatiensis* and *Fossaria dalli* were also present.

With respect to water chemistry parameters, analysis of variance found no significant differences for TDS, nitrate, or dissolved organic matter between sites where *Physa* sp. was present and where it appeared to be absent. However, significant differences were found for all three metals examined: water at sites where this snail was found contained marginally less cadmium and copper ($p<0.05$), and substantially less lead ($p = 0.005$) than sites where it was not found. Thus this species appears to be sensitive to metal contamination. Mean lead concentrations at sites where it was present were 4.4 + 0.9 S.E. μg/L, compared with the mean of 8.5 + 0.7 μg/L at sites where it was apparently absent. Since most of the 90 sites sampled exceeded concentrations of 5 μg/L for lead, this parameter may have contributed towards the limited distribution of this snail within the lake. Almost certainly, other (unmonitored) chemical parameters may also be of concern.

Trends

The shoreline habitats where *Physa* sp. occurred in the recent past and where it still presently occurs have undergone alteration as the density of recreational use has increased. At the same time, the surrounding watershed of Lake Winnipeg has experienced increased logging, with resulting nutrient, particulate and organic matter influx to the lake. Intensive agricultural uses, particularly in the hog industry sector, have contributed nitrogen, phosphorus, salts, heavy metals and dissolved organic matter to surface waters that ultimately drain to the lake. At the same time, expanded municipal drainage programs have channelled melt- and stormwaters more quickly from agricultural fields to the lake, carrying not only nutrients but pesticides as well.

It is expected that as the year-round and seasonal human populations continue to increase around the lake, adverse impacts will continue to escalate. Waterfront property values have steadily inflated, and bush and farmland previously held by speculators is continually being subdivided and developed. Construction of a road along the east side of the lake will continue to generate more access for clear-cut logging and recreation. The intensive livestock industry is undergoing rapid, almost uncontrolled, expansion in Manitoba, and large numbers of barns already exist in the Interlake region between Lakes Winnipeg and Manitoba, as well as in the watershed to the south and southeast. The Manitoba pig crop alone has increased by 30% from 1999 to 2001, with 6.5 million hogs produced in 2001.

Protection/ownership

Shoreline up to the high water mark is predominantly public reserve property. While a number of parks and provincial recreational areas exist around the lake, the amount of habitat disturbance and alteration in such places is not any less than that adjacent to private cottages and resorts. Indeed such areas are intensively utilized public beaches that may service considerably more users than do cottage areas, where the users are primarily the local cottage owners. Shoreline alteration may also be on a larger scale in park areas, where submerged rocks are bulldozed away to improve and enlarge beaches, and large docks, dikes and breakwaters are constructed in attempts to retain sand.

Site 6 is located in an area of high cottage and commercial density. Site 21 is a small park owned by a local recreational association. Site 28 is located near a country club and an area currently undergoing intensive vacation home construction. Site 57 is located on an Indian Reserve, but is the site of a commercial fishery marina. Site 77 is a public boat launch site, adjacent to cottages.

BIOLOGY

General

The general biology of this *Physa* is not known. For the other physids in Lake Winnipeg, reproduction occurs in June and July, and adults overwinter. While some individuals of *P. gyrina* in quiet backwaters of Lake Manitoba may survive beyond the second summer and reach a large size (Pip and Stewart, 1976), in Lake Winnipeg they remain relatively small and have an annual life cycle. Oviposition in *P. gyrina* has been reported to occur when water temperatures exceed 10º C (DeWitt, 1955).

Behaviour

In an aquarium, this snail is less active than *P. gyrina* and spends much of its time clinging to substrate in an inactive state. It was found to adapt to the aquarium environment less well than *P. gyrina*.

POPULATION SIZES AND TRENDS

Historical data collected by the author recorded this *Physa* at site 67 (Grand Beach) from 1961-1980, and at site 83 (Victoria Beach) from 1976-1984. It was not found at either of these sites subsequently. The earlier dates in both cases were the earliest visits to these sites by the author.

During 1975-1978, twenty-five sites were surveyed in Lake Winnipeg, including the west side of the north basin and Long Point near the northern end of the lake (Pip, 1978). Most of these sites were different from those studied in 1998 and 2001. Of these sites, only Victoria and Grand Beaches yielded this snail. None of the sites where it was found in 2001 were visited during 1975-1978.

In 1998, another survey of twenty-five sites was conducted by the author. Twenty-four of these sites were revisited during the present 2001 study (sites 3, 7, 18, 21, 29, 34, 41, 47, 51, 54, 58, 60, 61, 64, 66, 67, 72, 74, 78, 79, 80, 81, 83, 89). In 1998, one single specimen of this snail was found at each of sites 21 (Camp Morton) and 61 (Patricia Beach). When the twenty-four sites were revisited in 2001, this mollusc was still found only at site 21.

The disappearance of this snail from two historical sites, and possibly from site 61 as well, and its present known existence at only another five sites, suggests that this snail may be declining.

LIMITING FACTORS AND THREATS

Two major factors are of concern for the future survival of this snail:

A. The shallow, nearshore habitat, where human intrusion and disturbance are the most intense.
B. The eutrophication of the lake, which has accelerated substantially during the past decade.

Lake Winnipeg receives flows from a number of rivers and streams. Its drainage area is enormous, ranging from the Rocky Mountains in Alberta to the Lake of the Woods system in Ontario. Developments and activities within this vast area have the potential to affect water quality in Lake Winnipeg.

The Winnipeg River accounts for approximately 40% of the influent volume. The region drained by the Winnipeg River (ca. 137,000 square kilometres) contributes pulp and paper mill wastewaters, mining effluents and materials resulting from erosion of logged areas. The Saskatchewan River accounts for ca. 33% of the influent volume, and drains an area of ca. 416,000 square kilometres, where agricultural land use is often intensive, and includes drainage from forestry, large urban centers, and pulp mill effluent. Unlike the Winnipeg and Red Rivers, the Saskatchewan River enters the north basin of the lake near the lake's outflow, and therefore does not impact on the south basin to the degree that the Winnipeg and Red Rivers do. The Red River contributes only ca. 8% of the total volume, but it contains the wastewaters from Winnipeg as well as a number of other urban centres, and also carries substantial agricultural runoff. Sporadic flooding of the Red River basin is associated with spiking of various contaminants that are released into the water when communities, sewage lagoons, chemical and waste storage facilities and landfills are inundated. For example, after the 1997 flood, elevated levels of nutrients, heavy metals, PCBs, and pesticides such as toxaphene and DDTwere detected in Lake Winnipeg (IJC, 2000).

Innumerable smaller streams and drainage ditches discharge into the lake. During the last two decades, many municipalities around the lake have continuously enlarged and upgraded land drainage to promote agricultural land uses. This has resulted in accelerated entry of soil nutrients, agricultural chemicals and silt into the lake, particularly during spring run-off and during wet seasons. A number of streams in the southern portion of the watershed have shown significantly increasing trends of nitrogen and phosphorus loadings (Jones and Armstrong, 2001).

Shoreline habitats in Lake Winnipeg continue to undergo substantial residential and recreational development. Urban communities such as Gimli are located directly on the lakeshore, and dense cottage developments are proliferating in areas that formerly were either crown land or had remained undeveloped by private landowners. Such development brings with it a whole range of adverse environmental impacts, including:

- clearing of land for cottage lots, roadways and power lines
- physical modifications of shoreline by cottage owners and developers to construct and enhance beaches, and introduce marinas, docks, groins, boathouses, stairways, boardwalks, ramps, channels
- clearing and removing rocks from swimming and boating areas
- influx of nutrients and household chemicals from septic fields, pit privies and inadequately serviced holding tanks
- influx of nutrients from lawn and garden fertilizers
- influx of nutrients from pet waste
- disturbance from powerboats and personal watercraft, as well as all-terrain vehicles driven in shallow water
- use of herbicides, both on land to control weeds and in water to control aquatic macrophytes: by individuals, as well as by municipalities along roadways, rights-of-way, and by Manitoba Hydro along transmission line corridors; also spraying of lakeside parks, picnic grounds and campgrounds
- use of copper sulphate and other algicides to control problem algae
- use of pesticides to control nuisance insects
- littering and dumping of garbage
- use of toxic preservatives (e.g. pentachlorophenol, cuprinol and arsenic formulations) for docks, decks, cottage exteriors and hydro poles
- use of dust and ice control chemicals on roads
- fuel spills from marinas and boat engines, and parked vehicles
- leaching of toxins from marine paints on boat hulls (e.g. tributyltin)

Effects are particularly intense where urban centers or other year-round communities are located directly on the lakeshore, for example, Gimli or permanent Aboriginal communities. The latter may be accessed by ferries or winter roads across lake ice. Much of the truck transport of heavy goods to such communities occurs in winter. The winter roads contribute diesel emissions, oils, hydraulic fluid and other contaminants.

A road is currently under construction along the east side of the lake to facilitate logging; and this will soon be followed by recreational development of this area. As logging accelerates in the watershed, erosion and nutrient influx to the lake will increase. Soils on the Precambrian Shield along the east side of the lake are very shallow, often on steep slopes, and easily destabilized. Logging has been shown to have significant negative impacts on water quality of streams which drain clear-cut forests (e.g. Huttunen et al., 1990). Streams which drain logging areas contribute dissolved organic matter, suspended solids, woody debris and phosphorus to Lake Winnipeg (Pip, in preparation).

Manitoba Hydro commenced regulation of water levels in Lake Winnipeg in 1976, in order to manipulate flow into the Nelson River for hydroelectric purposes. It was recognized that such regulation could have a number of impacts, including increased shoreline erosion rates, narrowed beach widths and downgraded wetlands (MH, no date). A new transmission line along the currently undeveloped east side of the lake is planned, to be completed in the next ten years.

Within the south basin, shorelines have been eroding at rates of 0.5 m per year, with as much as 8 m or more per year at some localities (MH, no date). On the other hand, construction of docks and breakwaters has resulted in the accumulation of transported materials and changes to the shoreline. In other areas, cottage owners and municipalities have resorted to importation of fill and dumping of sand to reduce erosion rates. Poor shoreline management has exacerbated the problem where lakeshore banks consist of sand by allowing injudicious trail cuts and destruction of stabilizing vegetation to give cottagers an unobstructed view of the lake from their cottage. Use of all-terrain vehicles has become increasingly harmful. Attempts by landowners to stabilize crumbling banks and keep their property from shrinking often involve dumping of demolition waste from old buildings, metal scrap and rubber tires. Such material may contain hazardous materials.

Intensive livestock operations, particularly hog farms, have expanded dramatically in Manitoba. The number of hogs produced in Manitoba increased by 30% from 1999-2001, to a total of 6.5 million. This number is projected to burgeon even more significantly. Cattle and poultry production is also continuing to increase. Livestock production is particularly intensive on the west side of Lake Winnipeg, with some barns located within sight of the shoreline. Livestock operations contribute nutrients, heavy metals, salts and organic matter, which may escape from the property boundaries, or run off fields where the waste has been applied. A number of operators apply manure over the snow on fields in winter; the waste quickly escapes with spring meltwater into ditches and streams which drain into the lake.

The local response of many resort owners and cottagers to the escalating algal problem is to dump bulk quantities of copper sulphate and organic algicides into the water in an attempt to control nuisance algae. This, of course, leads to massive die-offs, and the nutrient release spawns another bloom, which requires another application. These chemicals are toxic to aquatic invertebrates and fish. The present study found that copper concentrations in such areas may reach toxic levels in the water (the highest recorded in the 2001 survey was 188 μg/L); as a comparison the Canadian Water Quality Guidelines for the protection of aquatic life recommend levels of not more than 2-6 μg/L. The copper, once applied, may accumulate in bottom sediments, to be released again at a later time when the sediments are disturbed or transported by long-shore currents to another part of the shoreline. Metals can also be recycled into the water by rooted macrophytes and bioturbation by benthic invertebrates.

A number of mining and ore-processing facilities exist in the eastern watershed of Lake Winnipeg. Most of these are gold mines. A large tantalum mine is located within the drainage of the Winnipeg River. Such operations contribute heavy metals and arsenic (the gold ore is largely in the form of arsenopyrite) to the environment. The acidity of Precambrian Shield waters renders metals more soluble and more toxic, and enables them to be transported downstream. A number of streams receiving such effluents are devoid of life for some distance. The present study found that mean concentrations of cadmium, lead and copper in the water were higher on the east than on the west side of the lake.

An additional source of heavy metal in shallow areas of the lake is lead shot, which has accumulated in popular waterfowl hunting areas, continues to poison waterfowl, and is subject to continuous, long-term leaching. Lead fishing sinkers and submerged refuse, sunken watercraft and discarded land vehicles are other sources. Lead levels in water at such sites have been found to be as high as 23 mg/L in the present 2001 study.

Pulp mills on the Winnipeg and Saskatchewan Rivers contribute significant organic waste to these rivers. Substantial reaches of the rivers downstream from the mills are blanketed by refractory organic matter which does not allow for the development of normal benthic communities. Mill waste from Pine Falls on the Winnipeg River may be carried to Traverse Bay in the lake (e.g. site 90), where it is transported and redistributed by currents.

SPECIAL SIGNIFICANCE OF THE SPECIES

This snail is especially significant in that it appears to be unique to Lake Winnipeg. Its biology has not yet been studied. Along with other endemic Canadian physids, notably western hot springs species, this gastropod may enhance our understanding of speciation within the Physidae.

EXISTING PROTECTION OR OTHER STATUS

No gastropods in Manitoba have any legal protection. The sites where this snail is known to occur are not protected from human disturbance. All of these locations are subject to recreational use and shoreline alteration.

SUMMARY OF STATUS REPORT

This physid is known only from Lake Winnipeg. The population is fragmented within the lake, and it is not clear why this gastropod has not colonized more areas of similar habitat type. It has disappeared from two sites where it was previously known to occur, and has not recolonized, indicating that it is sensitive to environmental changes. The projected escalation in destructive land and water use practices in and around the lake may pose increased threats to the survival of this snail in the near future.

TECHNICAL SUMMARY

***Physa* sp.**
Lake Winnipeg Physa
Lake Winnipeg, Manitoba

Extent and Area Information	
• extent of occurrence	2745 km^2
• specify trend (decline, stable, increasing, unknown)	decline
• are there extreme fluctuations in EO (>1 order of magnitude)?	?
• area of occupancy (AO)	5 linear km of shoreline ~ 5 ha
• specify trend (decline, stable, increasing, unknown)	decline
• are there extreme fluctuations in AO (>1 order magnitude)?	?
• number of extant locations	1 location with 5 subpopulations
• specify trend in # locations (decline, stable, increasing, unknown)	decline
• are there extreme fluctuations in # locations (>1 order of magnitude)?	no
• habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat	decline
Population information	
• generation time (average age of parents in the population)(indicate years, months, days, etc.)	estimated at 1 year
• number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)	?
• total population trend: specify declining, stable, increasing, or unknown trend in number of mature individuals	decline
• if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)	decline, based on # of sites
• are there extreme fluctuations in number of mature individuals (>1 order of magnitude)?	?
• is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange	yes
• list each population and the number of mature individuals in each	?
• specify trend in number of populations (decline, stable, increasing, unknown)	decline (15 - 30%)
• are there extreme fluctuations in number of populations (>1 order of magnitude)	no
Threats (actual or imminent threats to populations or habitats) - habitat alteration; human disturbance; water quality degradation with nutrients and contaminants from sewage lagoons, chemical (e.g. PCBs, and pesticides such as toxaphene and DDT) and waste storage facilities and landfills (e.g. heavy metals); fragmentation	

Rescue effect (immigration from an outside source)	low
• does species exist elsewhere (in Canada or outside)?	no
• status of outside populations	NA
• is immigration known or possible?	no
• would immigrants be adapted to survive here?	NA
• is there sufficient habitat for immigrants here?	yes
Quantitative Analysis	None

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BIOGRAPHICAL SUMMARY OF CONTRACTOR

Eva Pip received her B.Sc.(Hons.) and Ph.D. from the University of Manitoba, and held a postdoctoral fellowship from the National Research Council of Canada. She has more than 100 publications in the fields of aquatic mollusc and macrophyte ecology, as well as in water quality. Her particular current research interest is the cycling and bioaccumulation of heavy metals in aquatic ecosystems. She has been a faculty member at the University of Manitoba from 1977-1979, and the University of Winnipeg since 1979, becoming Full Professor in 1991. She has received numerous environmental and community service awards, including the Atchison Award for Excellence in Community Service, Manitoba EcoNetwork Environmental Award, the Rachel Carson Award, and Alpha Omega Woman of the Year. She has assembled the largest private shell collection in Canada, and is a member of the Mollusca specialist subgroup of COSEWIC.

Appendix I. Summary of shell characters for Michigan Physidae (from Te, 1975).

	P. skinneri	*P. gyrina*	*P. sayii*	*P. integra*
I. Whole shell characters				
A. Shell shape and whorl number				
Shell shape	EC	EC	OG	EO
Whorl number	4	5	5	4-5
B. Shell dimensions				
Shell length (mm)	9.3	15	19.2	12.7
SW/SL	0.48	0.52	0.65	0.63
AW/AL	0.50	0.52	0.55	0.57
SpL/SL	0.32	0.31	0.19	0.26
aSpL/SL	0.20	0.17	0.12	0.12
C. Qualitative characters				
Translucency	Tr	Op	Op	Op
Glossiness	Gl	Sh	Sh	Sh
Shell color	Hr	Hr	Hr	Hr
Spiral striation	n	H	Sb	n
Shell thickness	t	Rg	Rg	s
Columellar fold	Rg	Rg	Rg	Th
Parietal callus	vWd	Rg	Wd	Rg
Shouldering	n	sl	sl	sl
Rest callus	n	H	Pr	H
II. Aperture characters				
Aperture shape	lS	lS	nrOL	eS
Aperture size	Nr	Rg	Wd	Wd
Displacement	n	n	n	n
Outer lip	t	Rg	t	Th
Callus color	n	R/Wh	n	Wh
Insertion angle	Sm	Sm	Sm	An
III. Spire characters				
Spire shape	Bl	C	Dp	I
Spire angle	60	75	85	80
Indentation	so	Rg	sl	St
Sutural slope	sl	sl	sl	sl
Subsutural band	Wh	Y-Wh	Wh	Wh
Protoconch shape	Bl	Sp	Sp	Sp
Protoconch color	Rg	Rg	dS	dS

Key:

An = angled, angulate	H = heavy	R/Wh = reddish to white	Bl = blunt
Hr = horn	C = acute-conical	lS = loop-shaped	s = somewhat
solidDp = depressed	n = none	Sb = subobsolete	dS = darker than shell
nrOL = narrowly ovate-lunate	Sh = shiny	EC = elliptical-subcylindrical	Nr = narrow
sl = slight	EO = elongate-ovate	OG = ovate-globose	Sm = smooth
eS = ear-shaped	Op = translucent	so = some	Gl = glossy, polished
Rg = regular	Sp = pointed-conical	t = thin	Th = thick
Tr = transparent	vWd = very wide	Wh = white	Y-Wh = yellow to white