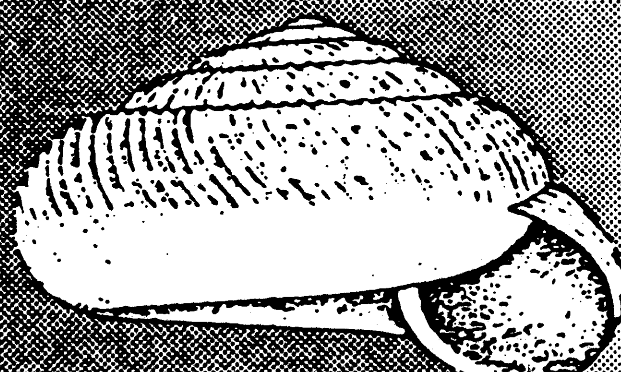
NATIONAL RECOVERY PLAN

FOR

IOWA PLEISTOCENE SNAIL

(*Discus macclintocki* (Baker))

U.S. Fish and Wildlife Service, 1984



NATIONAL RECOVERY PLAN FOR IOWA PLEISTOCENE SNAIL (DISCUS MACCLINTOCKI)

by

Terrence J. Frest
Department of Geology
University of Iowa
Iowa City, Iowa 52242

DISCLAIMER

This is the completed Iowa Pleistocene Snail Plan. It has been approved by the U. S. Fish and Wildlife Service. It does not necessarily represent official positions or approvals of cooperating agencies and it does not necessarily represent the views of the individuals who played the key role in preparing this plan. This plan is subject to modification as dictated by new findings and changes in species status and completion of tasks described in the plan. Goals and objectives will be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints.

Approved: Harvey K. Nelson Date: 3-22-84
Regional Director
U. S. Fish and Wildlife Service

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PREFACE

The Iowa Pleistocene snail (Discus macclintocki) (Baker)) was listed as endangered in 1977. The species, a medium sized, low spired endodontid, is of particular interest because it is a glacial relict. Widely distributed in the Midwest during the Pleistocene, D. macclintoki is now restricted to about eighteen small sites in or near the relatively unglaciated Driftless Area in Clayton and Dubuque Counties, Iowa, and Jo Daviess County in Illinois.

Suitable habitat is limited to from a few tens to a few hundreds of square feet at each site. The total extant population may not exceed 60,000 individuals. All snail colonies are on algific talus slopes (Frest, 1981) that mimic environmental conditions widespread in the Pleistocene but unavailable on a large scale today. Discus macclintocki has unusually narrow temperature and moisture tolerances and food preferences. The necessary conditions (buffered microclimates and unusual flora) persist on only a few of the most botanically diverse, relatively undisturbed algific slopes.

This recovery plan outlines habitat requirements and life history, summarizes past, present, and potential distributions and suggests prioritized recovery actions. It is intended to provide decision makers with a possible set of procedures which if implemented will result in changing the status of the Iowa Pleistocene snail minimally from endangered to threatened, and feasibly to delisted. The plan additionally sets guidelines for protection of the snail's habitat, public education, monitoring population status, and needed research.

The plan has three parts. Part I includes a description of the Pleistocene snail, its distribution, life history, habitat requirements, reasons for decline, current population status and trends, possibilities for reintroduction, and associations with other listed species.

Part II is a step-down version outlining in orderly fashion the needed management and research efforts. The prime objective is to move the Iowa Pleistocene snail to non-endangered status, preferably delisted. Minimum requirements for transfer to threatened status are documentation of protection of sixteen existing colonies, and documentation that each colony is an independently viable breeding unit sufficiently dispersed such that a single catastrophic event is unlikely to eliminate all or a major portion of the total population. Delisting could be considered upon documentation of protection for twenty-four such breeding colonies.

Part III is the implementation schedule.

PART I

Description

The Iowa Pleistocene snail (Discus macclintocki (Baker)) is an average-sized Discus with an adult width of 6-8 mm. The moderately high-spired (almost dome-shaped) shell is tightly coiled: adults typically have six whorls (Figure 1). Shell color is either brown or greenish-white. Ribs are relatively fine and confined to the upper half of each whorl. The species has a moderate-sized umbilicus and lacks a parietal callus. Refer to Appendix I for a comparison of the four upper Midwest Discus species and identification characteristics for modern or fossil material.

The first description (Baker, 1928) is of two forms, the nominate subspecies and D. m. angulatus. As both were named from fossils, the distinguishing features are conchological only. D. m. angulatus is said to be more depressed and more widely umbilicate and to have a subangular periphery. Both subspecies were accepted by Pilsbry (1948). In fossil specimens, intergrades are rare and populations usually unmixed, as noted by Baker. Living populations are more variable and both forms are present equally. Cursory biometrics suggest complete integradation, and only the nominate form is here recognized; but the point needs further confirmation.

Distribution

The Iowa Pleistocene snail has a lengthy geologic record (Kansan-Wisconsinan: approximately 300,000-500,000 YBP to present) in parts of the upper and central Midwest. At its maximum, the species' range included parts of southern Iowa and adjacent Nebraska, northern Missouri, west and central Illinois, Indiana and Ohio. Most fossil sites are on the Missouri, Mississippi, and Illinois Rivers; probably this is a minimal range, as earlier and non-loessal (not in a river valley) localities are scarce. Apparent center of distribution until recently was Illinois.

The Iowa Pleistocene snail is a recent arrival to the Driftless Area. The oldest common fossils here are less than 10,000 years old. There are eighteen existing sites located in six separate drainages in Clayton and Dubuque counties, Iowa, and in Jo Daviess County, Illinois (Figure 2). First described as a fossil in 1928, the species was found living in 1955 (Hubricht, 1955). This colony remained the only site until recent research turned up the additional localities (Frest, 1981, 1982). Details of present and past distribution are presented in Appendix II.

Life History

The Iowa Pleistocene snail occurs in eighteen small areas on larger algific (cold producing) talus slopes in northeastern Iowa and northwestern Illinois. The seven largest colonies contain between 2,000-4,000 individuals each,

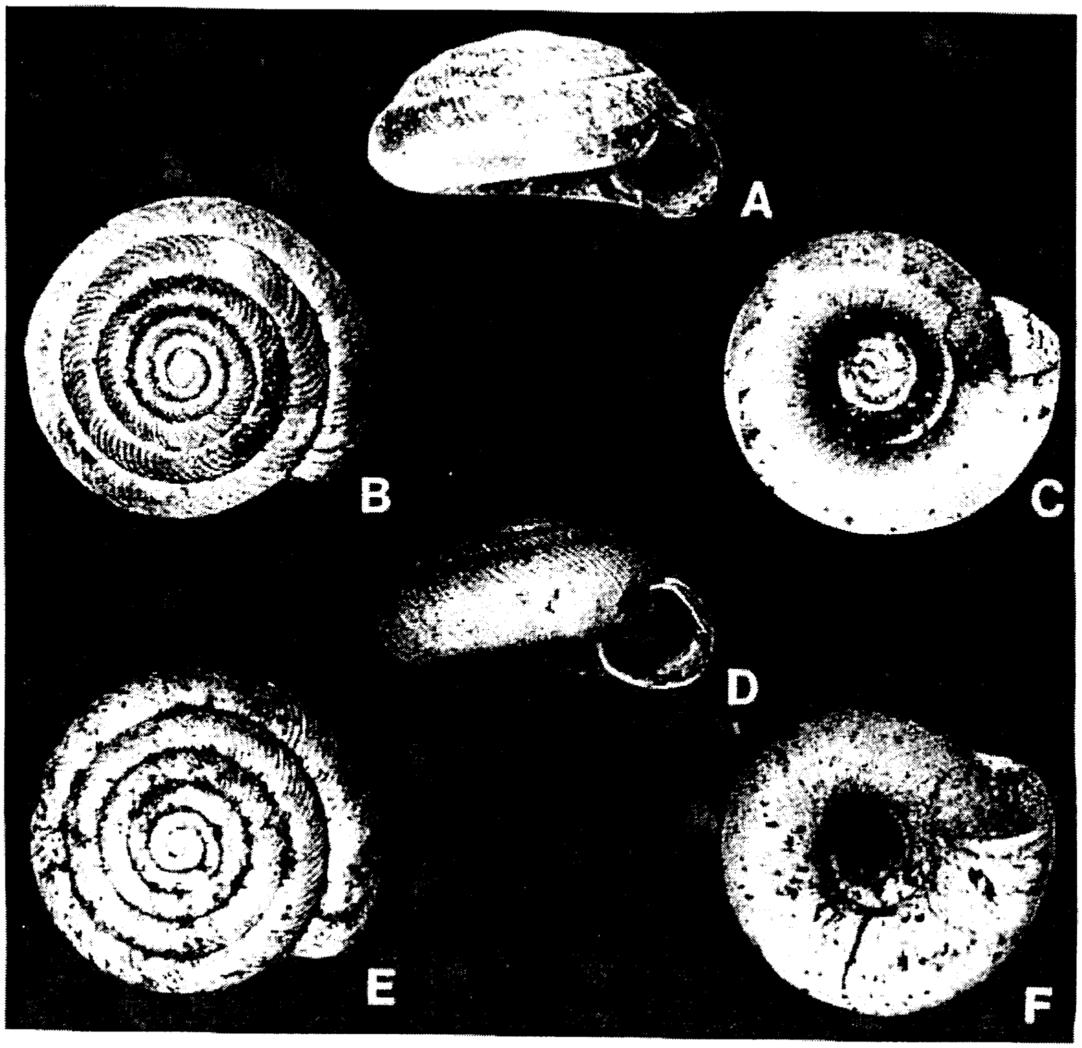

Figure 1. Discus macclintocki(Baker), A-C, side, top, and basal views of modern specimens from Dubuque County, Iowa; D-F, same views of Peoria Loess specimens from Henderson County, Illinois. All approximately x 6.

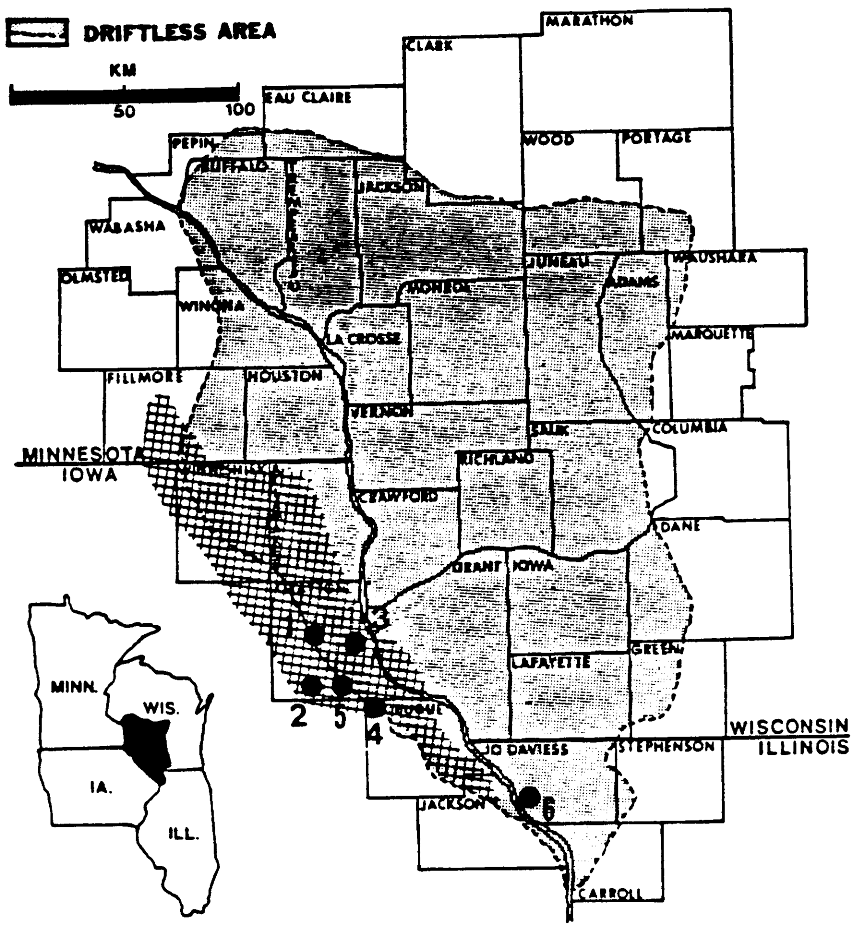

Figure 2. Map showing extent of Driftless Area (dot shading), distribution of known algific talus slopes (lined areas), and locations of drainages with *D. macclintocki* sites (numbered circles). Numbers refer to site clusters detailed in Table 1.

or about 30 percent of the estimated population. From observations of existing colonies a viable breeding population seems to be between 50-150 individuals per year, although from a genetic standpoint a population of 500 is desired. Each colony is small, and population density varies greatly from year to year.

In laboratory colonies at optimum conditions, snails remain active all year long but a period of greater activity lasts from January to October. Daily photoperiod between these dates is long enough to stimulate both greater activity in general and breeding in particular. In the wild the snails become less active about August, presumably due to drying of habitat, but remain on or near the soil surface until the first hard freeze or until October, whichever occurs first. Snails then largely disappear from sight as they retreat into the soil and hibernate. If conditions are favorable, active individuals can be seen at some sites throughout the year, but at most freezing of exuding moisture effectively solidifies the slope by December. Commonly, the slope remains solid ice until late March or April, at which point snail activity resumes.

Breeding season in laboratory colonies is from January to August; however, observed breeding in the wild seems confined essentially to the period from late March-April to August. Like most North American land snails, the Iowa Pleistocene snail is hermaphroditic but not self-fertilizing (Pilsbry 1948) and all adults can apparently both lay eggs and fertilize others. Length of the period from copulation to egg laying is not known, but multiple broods from the same individual each year are common. Clutch size varies from two to six, with three being typical. Hatching occurs about 28 days after eggs are laid. Viability is high with better than 90% commonly hatching.

Total life span is a minimum of five years, with six or seven possible for some individuals. Lab-reared snails require between two and two and one half years to reach sexual maturity. In any given population, the proportion of juveniles to adults is at least six to one and more commonly is better than ten to one. Juveniles are typically more active than adults; overwintering juveniles are the first to emerge, and also the last to hibernate. Young individuals are less often seen outside the confines of the colony or on less than optimum substrata, presumably because they are more delicate.

Obvious causes of mortality are dessication and predation by the short-tailed shrew (Blarina brevicauda). Juveniles are comparatively susceptible to drying out, but shrews seem to ignore less than half-grown individuals and markedly prefer large adults. In normal years few individuals wander outside of normal colony confines (as determined by finding numerous dead specimens), but in late spring and summer in very humid years and after major thunderstorms, individuals are occasionally encountered in anomalous places.

Eggs are laid under logs and bark, in protected moist rock crevices, and in the soil a short distance beneath the surface. Adults and young hibernate in much the same places. Many snails retreat six inches or more into the leaf litter in which they live. Individuals of all ages prefer leaf litter with a high proportion of deciduous leaves. They typically avoid areas with a moss ground cover or coniferous needle litter unless weather conditions are exceptionally good. Because of the snail's limiting temperature and moisture requirements, successful migration is nil and such normal avenues as stream transport and hoarding or collection by small animals are ineffective.

Habitat Requirements

1. Algific talus slopes. At present, the only suitable habitat for *D. macclintocki* is on certain portions of algific talus slopes, a term coined by Frest (1981, 1982) to describe a type of habitat and accompanying biota documented thus far only from the Driftless Area. Algific talus slopes are developed over the entrances to small fissures and caves. Air circulation and groundwater infiltration from the surface produces more or less permanent underground ice whose incomplete melting produces a constant stream of moist cool air which filters through a thin plant and litter cover over an extensive rock talus. A cross section of a typical Silurian algific slope is given in Figure 3; Ordovician slopes have a less well-developed fissure-cave system. Such slopes form only under unusual circumstances. They are developed only in well-dissected areas with significant rock exposure and recent proximity to a large ice sheet. Such proximity induces periglacial conditions in a usually temperate locale. Formation of a mechanical karst terrain with fissure and cave systems produced by ice wedging and outsized congelifractate talus slopes induced by ice breakdown of rock is a necessity.

   Algific slopes are most likely to occur in large porous carbonate rock units that cap eroded slopes and are underlain by a unit relatively impervious to ground water flow. Such cliff-forming units as the limestones of the Ordovician Prairie du Chien Formation and Galena Group and the dolomites of the Silurian Hopkinton Formation are ideal because they combine relatively massive and resistant, yet porous beds with more thinly-bedded units that yield an appreciable talus. Best exposures are at the eroded edges of the outcrop built of each, i.e., the cuesta edges of the Upper and Lower Magnesian and the Niagaran Escarpments. Mechanical karst terrain does not develop well in the sandstone cliffs of the St. Peter or Trempleau. Dolomitized or mineralized portions of the Galena Group (e.g., the Upper Mississippi Valley lead-zinc mining district of Iowa, Illinois, and especially Wisconsin) are apparently unsuitable.

   Periglacial effects are most pronounced in the Driftless Area on steep, north-facing slopes along the escarpments, and nearly all algific slopes meet these criteria. They function as refugia because the talus is left permanently cool and moist. Even in hot summers, ground temperature seldom exceeds +10°C or in winter, falls much below -10°C (Solem, 1976; Frest, 1981, 1982); average humidity often exceeds 60 percent. Algific slopes are believed to provide a buffered microclimate that is analogous to that prevalent in the glacial range of the Iowa Pleistocene snail.

2. Other factors. Besides the unusually tight temperature and moisture requirements that make D. macclintocki a stenotopic species, several other factors limit distribution. To maintain moisture and humidity and provide forage, a rich but loose soil cover is necessary. That over algific slopes is thin (generally under 12") but adequate. Only well vegetated slopes have a thick litter cover; others are too cold to allow breeding, and these also often lack sufficient forage. The snail is also a moderate calciphile, and hence inhabits only slopes developed on strongly calcareous soil. Well-vegetated areas also provide a degree of protection from the sun, i.e., less chance of dessication. While not a strongly nocturnal species, the snail does tend to avoid strong light and exposed settings.

   Finally, the Iowa Pleistocene snail has a rather limited diet. It prefers white and yellow birch leaves and those of hard maples, trees with limited distribution in Iowa. It will also eat dogwood and willow leaves, but refuses a wide variety of food sources commonly utilized by other land snails (Frest, 1981). All of the mentioned forage species are found preferentially on rich algific slopes in the Driftless Area. In summary, the species is now limited to algific slopes, most particularly those that are large, well vegetated, and relatively undisturbed.

Reasons for Decline

1. Glacial History. Interglacial populations of the Iowa Pleistocene snail likely at best represent only a small fraction of glacial numbers, confined as they are to relict areas. The species is a normal component, sometimes a dominant one, of the Pleistocene glacial Midwest Biome (Frest and Fay, 1980). In single fossil sites, especially in the Peoria Loess, millions of individuals are preserved. Midwest Biome temperatures are thought to have ranged between ± 40°C. In interglacial periods, algific slopes provide the most analogous climate.

   Thus the major long-term cause of decline is cyclic climatic change. The species has survived several such cycles in the past, however. With a return to glacial conditions it will be resuscitated over a major part of the upper Midwest, provided its relictual areas are preserved and maintained.

   Once the necessary algific talus slope terrain develops near the close of a glacial, geologic factors become comparatively unimportant. Interglacials are short enough, and erosion slow enough, that degradation and loss of habitat due to large-scale geologic processes is probably minor. Effects of small-scale processes will be considered below.

2. Human Disturbance. The most important causes of decline of Iowa Pleistocene snail interglacial habitat is human disturbance. It is

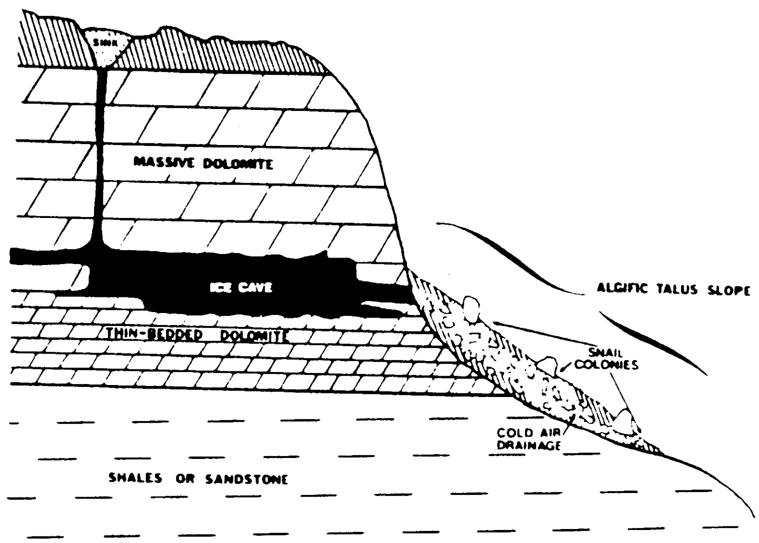

Figure 3. Cross section of typical Silurian algific slope with well-developed sink and cave system. Ordovician slopes are often more diffuse.

estimated (Frest, 1982) that about 75 percent loss of habitat has occurred in the last 150 years. Major documented causes are ranked from most to least important below; for details, see Frest, 1982.

a. Slope clearing is a major factor. Removal of trees, even without concomitant effects, destroys the major food sources, lessens litter accumulation, and leaves the slopes more exposed to seasonal temperature extremes. Clearing is conducted for pasturing, to obtain lumber, and to facilitate road building. In a few cases, power line construction was the motivation.

b. Pasturing of domestic animals, particularly cows, has obliterated a number of suitable slopes. They are fragile and easily subject to trampling damage. Because algific slopes are often too steep and rocky for tillage, and for the same reasons are not ideal locales for economically valuable tree species, many have been used as pastures. Much of the potentially suitable habitat in Wisconsin has been pastured. The overall effect, aside from obliterating the unique biota, is to increase soil erosion. Most slopes are overgrazed and unstable under current weather conditions if vegetation is removed.

c. Human traffic is also a major cause of damage to many algific slopes. The damage is due to denudation of inhabited stretches due to rock falls, but also to compaction of litter and crushing of snails by trampling. At least seventy of the known slopes show some damage attributed to foot traffic. Among the instances observed were hunters, casual hikers, plant and mushroom collectors, and researchers on algific slope biota. Scientific or amateur collecting and field study must be included under this heading and causes appreciable damage.

d. Road building, either for vehicular travel or to allow easy access to hilltop fields, has also caused considerable attrition of slopes. Aside from damage to the litter cover, any disruption of the air circulatory system is potentially disastrous.

e. Subsurface modifications such as quarrying also eliminate habitat by a combinaton of physical destruction of the surface and disruption of the subsurface ice cave or fissures. Other examples in this category include house construction, installation of sewer lines or other underground pipelines, mining and drainage excavations.

f. Miscellaneous other human related factors. In general, it must be noted that any surface or subsurface modification to the slope itself or to the related fissures, sinks, and caves on the slope above, could result in extinction of a colony. Some observed activities, whose importance is either minor so far or difficult to assess, include: 1) waste disposal (solid or liquid) on talus slopes or sinks in adjoining fields; 2) herbicide damage; 3) pesticide damage. Possible instances of all of the above are cited in Frest (1982). No major instances of deliberate vandalism have yet been observed, but are a possibility to be considered.

3. Natural calamities. Under this heading are listed several natural factors which have been observed to damage algific slopes. In no instance has destruction of an entire slope occurred and damage is usually limited in areal extent. Most are also not readily preventable, but because some colonies are small, attempts to repair such damage to D. macclintocki sites are warranted and feasible.

   a. Small-scale geologic processes such as rockfalls and stream undercutting have damaged algific slopes by burying critical portions or physically removing small areas. One example is cited on page 10.

   b. Biotic factors. Predation by shrews is a major cause of adult mortality. The same factor operates on most land snails above a certain size, and should not normally be a major cause of concern. Trampling by deer and other traffic causes minor damage, but the tendency for animal trails to be narrow and rather constant in location on the slopes limits possible damage. Tree falls in critical areas likewise can cause severe but highly localized damage. Hubricht (1972) mentions predation by cychrine beetles as a cause of mortality at one colony. This contribution to juvenile mortality remains unassessed.

   c. Weather related factors. Unusually severe winters or summers undoubtedly cause major damage from time to time, as the influence of cold air drainage can be counteracted by severe events. Such are unlikely to cause complete extinction, however; the Iowa Pleistocene snail survived the so-called Altithermal or Hypsithermal, a period of unusually warm and dry weather which occurred at about 6,000 YBP. Tornadoes or lightening strikes also cause damage to individual colonies. Forest fires may be a problem, if severe, but the cool and moist slopes are reasonably insulated from direct fire damage. Changes to vegetation and soil chemistry of surrounding areas could have major impact, however.

Current Population Status and Trends

Relocated in 1955, the sole then-known Iowa Pleistocene snail colony was investigated but not censused in 1976 (Solem, 1976). The remaining colonies were discovered in the period 1979-1983, so that only short-term and mostly subjective data is available, and one colony is not located precisely due to discovery only from picked litter. Despite limitations and the need for further research on these points, some useful generalizations can be made. Due to new discoveries the total known population has increased considerably since 1976. Many colonies have decreased in size since their initial discovery.

The status of all known colonies is reviewed individually below. Summaries of population size and present ownership are given in Table 1; threats and damage to individual colonies are discussed individually under drainage headings. Numbers refer to Figure 1 and Table 1.

1. <u>Dry Mill Creek</u>. The Dry Mill site cluster in Clayton County contains about 16 percent of the total population. None are presently protected in any way. Locality 1981-46 is very difficult to reach or sample and is probably the best protected from human disturbance of all known colonies. It is untouched by pasturing or lumbering, but its extreme steepness and location make it particularly subject to erosion. Any attempts at lumbering would be especially disastrous. Localities 1980-35 and 1981-45 have been subject to some pasturing, and 1981-45 is near extinction from this cause. 1980-35 suffered a rockfall in 1981 that covered more than half of the population. 1981-12 is a dense colony that is easily trampled but appears relatively stable.

2. <u>Bear Creek</u>. All three sites are on state park land in southern Clayton County, a fact that has not prevented definite human damage to two of the three. The originally discovered colony (1980-43) has suffered at least 70 percent attrition since 1976, due to: 1) tornado damage and subsequent trampling by the cleanup crew; 2) plant collectors; 3) casual trampling by visitors to the nearby ice cave entrance; 4) trampling by botantists and malacologists. The largest colony (1980-44) has had about 60 percent attrition in two years due mostly to scientific activities such as snail sampling, plant collecting, and temperature/humidity data collecting. Some damage by hunters and hikers was also noted. 1981-32, a peripheral colony, is near extirpation due to limited size and tree fall. Collectively the Bear Creek colonies account for about 5 percent of the total population.

3. <u>Buck Creek</u>. These recently discovered seven colonies in eastern Clayton County make up about 60 percent of the known population and include the largest colony. All are currently unprotected. Population estimates are extremely tentative; the size and precise location of the colony at 1981-38 are as yet unknown. 1981-34 has been partially cleared and pastured, and pasturing damage is also evident at all of the remaining sites, except 1981-24 and 25. Die-off of birches is noticeable at 1981-29, 35, and 38. Locality 1981-29 could easily succumb completely if further damage of any sort occurs. 1981-24 is dangerously close to a roadway. Little information on population trends is available, but it is noteworthy that numerous other algific sites in the area have been completely destroyed, damaged in various ways, or do not now support relict snails. Some damaged sites have

surviving colonies of other glacial relicts and could probably support *D. macclintocki* if protected. One complex of five slopes is now owned by The Nature Conservancy and may be a good reintroduction site.

4. Pine Creek. The three existing Dubuque County sites have about 20% of the total population. A colony was discovered in 1979 but extirpated a few months later by hikers; it probably had a population in the range of 50-100. A small colony (population 150) was discovered in 1983. All remaining colonies have been damaged by foot traffic from hikers, spelunkers, and fishermen. They are on trails to a well-known local cave, and 1981-61 is on a game trail. The sites are in the Iowa state preserve system and will be protected.

5. Hewett Creek. A single small (estimated population 500) site was discovered in 1983. This locality lacks birches but is otherwise undisturbed; it contains about 2.5% of the existing known species population.

6. Yonkers Bluff, Illinois. One site in Jo Daviess County is privately owned and protected through the Ilinois Natural Heritage Landmark program. The site is not threatened by erosion, human disturbance or grazing and contains an estimated population of 2,000.

The population figures in Table 1 represent minimum figures derived by counts from small-scale litter samples selected from accessible areas of average density. Obviously, complete sampling is not possible. Based on visual estimates under optimum weather conditions, and repeated visits and very small-scale sampling at selected sites, it seems likely that confirmed population underestimates real population by a factor of about 3. Thus, the existing actual population at known sites is believed to be about 60,000, rather than the 20,000 indicated in Table 1. However, estimates for the very small colonies are probably close to the actual figures.

In general there has been a noticeable decline in a comparatively short time span. Most of the recorded sites (4 of 6) are on public property and hence not subject to such practices as grazing or lumbering. Nevertheless, it is evident that a passive protection scheme is insufficient. Normal human traffic, especially as pressure on existing public facilities continues to grow, could extirpate the species. This is especially striking at the Pine Creek sites, which are not easily accessible and have relatively few visitors.

At present, only six (33 percent) of the eighteen extant sites are publicly owned. In the author's opinion, none of the sites is adequately protected. Several sites (1980-35, 1981-45, 1980-43, 1981-43, 1981-29, and 1983-15) have populations so small that they are probably near minimum sustainable size (below from a genetic standpoint) and hence in immediate jeopardy. None are completely unaffected by human disturbance (1981-46 and 1981-25 are closest to undisturbed conditions), and most show signs of major disturbance in the immediate past.

Table 1. Population sizes for *D. macclintocki* sites. Locality numbers are from Frest (1981, 1982, in prep.)

LOCALITY	POPULATION	STATUS
Iowa		
1. Dry Mill Creek		
1980 - 35	*ca.* 150	U
1981 - 12	*ca.* 1,000	U
1981 - 45	? 50 - 100	U
1981 - 46	? 1,000 - 2,000	U
2. Bear Creek		
1980 - 43	100 - 200	S
1980 - 44	400 - 600	S
1981 - 32	50 - 100	S
3. Buck Creek		
1981 - 24	600 - 1,000	U
1981 - 25	?1,000 - 2,000	U
1981 - 29	*ca.* 100	U
1981 - 33	*ca.* 2,000	U
1981 - 34	*ca.* 4,000	U
1981 - 35	*ca.* 2,000	U
1981 - 38	unknown	U
4. Pine Creek		
1980 - 53	600 - 1,000	S
1981 - 61	2,000 - 3,000	S
1983 - 153	100 - 150	S
5. Hewett Creek	*ca.* 500	U
6. Yonkers Bluff	2,000	S

S - in state park, state preserve system, or Heritage Landmark Program
U - privately owned and unprotected

In order to better assess trends at existing colonies, revisits were made in 1981-83 to sites discovered in 1979-1981. Results are summarized in Table 2.

Table 2. Population trends for sites discovered prior to 1981.

LOCALITY	ESTIMATES		REASONS
	Past	Current	
34	4,000 (1982)	3,000 (1983)	Pasturing
35	300 (1980)	150 (1981)	Rockfall and trampling
43	300 (1976) 400 (1980) 200 (1981)	100 (1983)	Tornado, plant collecting, snail collecting, trampling
44	600-1,000 (1980) 400-600 (1982)	200-400 (1983)	Trampling from scientific study and hikers
53	600-1,000 (1980)	600-1,000 (1982)	Appears stable
unnumbered Pine Creek	50-150 (1979)	0 (1980)	Trampling by hikers, spelunders, or fishermen

Associations with other Listed Species

Several algific talus slopes with Iowa Pleistocene snail colonies also have populations of the threatened Northern Monkshood, *Aconitum noveboracense*. These are 1980-53, 1981-32, and 1981-66. Associated with *D. macclintocki* occasionally are at least three other glacial relict snails, all of which should probably be considered for Federal listing. In addition, a number of plant and snail species that are either northern disjuncts or relicts are found on the same or other algific slopes. Some of these are on state endangered or threatened lists (e.g., Roosa and Eilers, 1978).

It must be borne in mind that with six or seven exceptions, all of the presently known algific talus slopes were located within the past three years. Based on geologic criteria, about 15,000 square miles of Minnesota, Illinois, Wisconsin, and Iowa may now have or have had such slopes (Figure 4). They have been confirmed as yet from only a small portion of this area. The possibility of significant numbers in Minnesota and Wisconsin was only confirmed in 1982 (Frest, *in prep.*) and in Illinois in early 1983.

Most of the known slopes have not been systematically surveyed for either fauna or flora; available data is summarized in Frest (1981, 1982 (Iowa), in prep. (Minnesota, Wisconsin). Algific slopes are sufficiently unique and have enough intrinsic biological, ecological, and geologic value to be accorded special preservational status. They constitute a distinct and readily characterized type of equal ranking with such major and better known ones as maple-basswood or oak-hickory forests. Management needs and protection priorities for all relict species are similar enough so that the habitat may be considered as a whole in most cases.

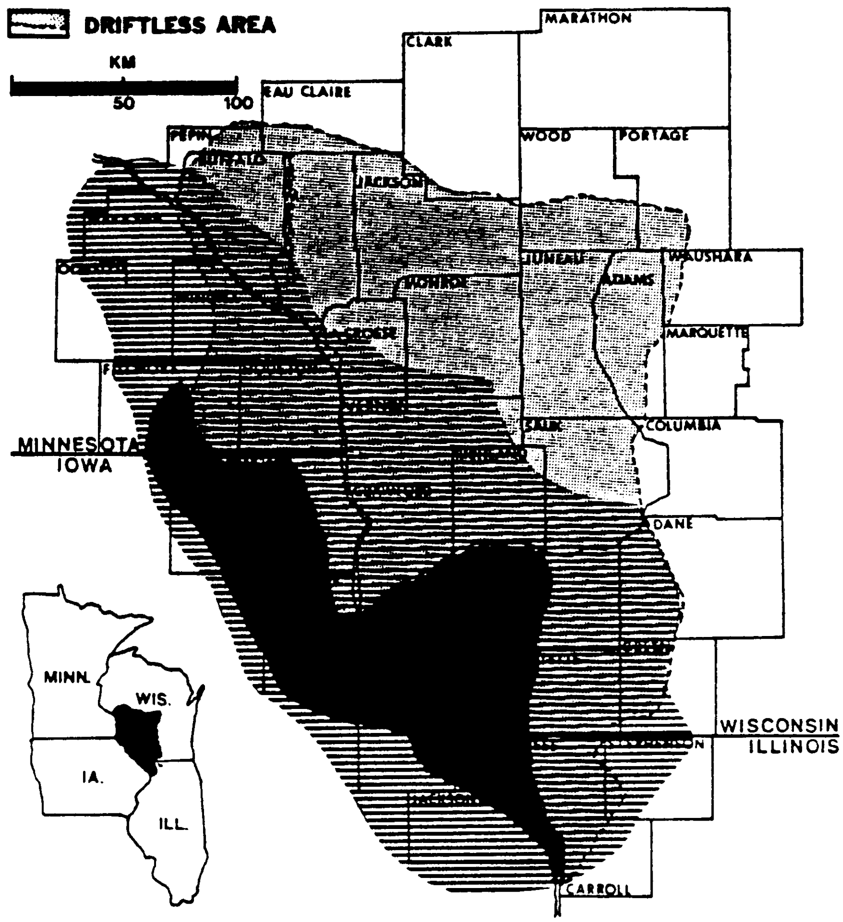

Figure 4. Possible extent of algific talus slopes in or near the Driftless Area. Lined area indicates potential distribution: black area includes all known localities.

PART II

Abbreviated Step-down Outline

1. Habitat Protection

    1.1 Survey potential habitat for new colony sites

    1.2 Determine requirements for upland buffers

    1.3 Develop and Implement Interagency Agreement between FWS and State Conservation Agencies for habitat protection measures (signing, fencing, etc.) at publicly owned sites.

    1.4 Evaluate land protection strategies (easements acquisition, etc.) for colony sites on non-public lands

    1.5 Implement required habitat protection measures (signing, fencing, etc.) for colony sites

2. Population Management and Protection

    2.1 Monitor population trends at all colony sites

    2.2 Conduct life history studies

    2.3 Determine forage habits

    2.4 Determine effects of environmental contaminants on snail populations

        2.4.1 Conduct toxicity tests on surrogate species using agricultural chemicals utilized near colony sites

        2.4.2 Monitor colony sites for evidence of pesticide or herbicide contamination

        2.4.3 Conduct studies for potential ground water contamination

    2.5 Reestablish snail colonies

        2.5.1 Maintain laboratory breeding colony

        2.5.2 Identify suitable reintroduction sites

        2.5.3 Provide appropriate land protection as in 1.4 and implement necessary habitat protection measures as in 1.5.

        2.5.4 Reintroduce snails

2.5.5 Monitor reintroduction sites

2.6 Law enforcement monitoring of colony sites

2.7 Investigate geologic history

3. Information and Education

3.1 Insure information transfer to appropriate government agencies and officials.

3.2 Provide information on status of snail and its requirements to landowners of colony sites

3.3 Prepare slide programs and information brochures

3.4 Ranger/naturalist talks

Recovery Plan Narrative

OBJECTIVE: TO REMOVE THE IOWA PLEISTOCENE SNAIL FROM ENDANGERED STATUS

The most important feature of this plan is the protection of existing D. macclintocki colonies by: 1) gaining control of relevant algific talus slopes; 2) protecting them from human disturbances. As much as practicable, existing talus slope areas and adjacent upland mechanical karst must be restored to its original state, maintained, and stringently protected. Secondly, to establish a sizeable and dispersed biologically viable population, reintroduction efforts should be made. Finally, in order to ensure the success of both sorts of recovery efforts, a monitoring program should be set up to document positive response to protection efforts.

The Iowa Pleistocene snail can be considered for reclassification from endangered to threatened status if permanent protection of sixteen of the existing colonies can be achieved and documentation and stable or increasing populations at these sites can be provided by a monitoring program. Delisting of the species can be considered if documentation of stringent protection of at least 24 or more sufficiently dispersed viable breeding colonies is obtainable. A viable population from a genetic standpoint would be an effective breeding population of 500 individuals, however, this should be confirmed in future life history studies (task 2.2).

1. Habitat Protection. Because the total population is so small, known sites must be preserved if the species is to survive. Human related disturbance has been documented as the major cause of decline of existing interglacial populations (Frest, 1982). Prevention of unauthorized entry by humans or domestic animals into colony sites is the most significant way to prevent disturbance at these sites. No intervention to prevent natural causes of damage or decline is recommended.

    1.1 Survey potential habitat for new colony sites. It is likely that other sites, perhaps enough to allow consideration of transfer to threatened status, remain to be found. Refer to Appendix III and Frest (1981, 1982) for evaluation of exploration status. In addition, some known sites would probably support colonies if protected. These should be afforded the necessary degree of protection, and signing, fencing, and monitoring programs initiated, as above. An evaluation of potential Iowa sites is given in Frest (1982), and Minnesota and Wisconsin sites are considered in Frest (in prep.).

    1.2 Determine requirements for upland buffers. To reduce protection costs, accurate determination of this parameter is required. Fluorescent dye tracing in upland sinks is the preferred method. Algific talus slopes are vulnerable to adverse modifications and changes to surface areas and sinkholes which drain into fissures, as well as any changes to the subsurface components. Examples include deforestation and pesticide/herbicide usage, and filling or blockage of sinkholes by waste or garbage disposal, i.e., any increase or decrease of water and air flow or deterioration by chemical or biological means of input ground water. Natural upland forest cover should be restored where necessary.

1.3 Develop and Implement Interagency Agreements. An interagency agreement should be worked out between the FWS and state conservation agencies to delineate responsibilities and funding for habitat protection measures at publicly protected sites. This should be in greater detail than existing cooperative agreements provide for.

1.4 Evaluate land protection strategies. Because colony sites are fragile, open to traffic and limited in area, this is the most practical single step to protect *D. macclintocki* sites from human or domestic animal disturbance and adverse modifications. To accomplish this, rather stringent control over the sites by government agencies or private conversation agencies is advocated. Possible measures include fee acquisition, easement, cooperative agreement, or lease. Whatever the arrangement, guarantees that the appropriate agency can legally take the necessary steps to reduce or eliminate essential habitat destruction or adverse modification are vital. Landowners should be contacted and informed in an attempt to gain their cooperation. Many already prefer to leave the relevant areas in forest, but the threats to the snail colonies from normal activities should be spelled out. Federal and State agencies should bear all or a major part of the fencing and signing costs. Emphasis on the rarity and unusual history of the sites may encourage a protective and conservationist attitude toward them.

1.5 Implement required habitat protection measures. The colony site proper and/or the surrounding algific site should be fenced to prevent unauthorized human and domestic animal access. All plans to fence sites should ensure adequate but not excessive or unnecessary coverage. Signs can be posted at the perimeter of colony sites and adjacent algific talus slope borders to discurage entry. Signing may discourage casual damage and emphasize the importance atttached to the sites. After signing and fencing sites, access roads or trails should be removed to further discourage access to the site. Public facilities nearby should be shifted to less fragile and distant portions of the tract.

2. Population Management and Protection. Adverse modifications to Iowa Pleistocene snail sites must be prevented to preserve existing habitat.

2.1 Monitor population trends. After sites have been protected, periodic monitoring is necessary to determine if conservation efforts are succeeding or if management efforts should be modified. The information so acquired should be sent to the appropriate regional Fish and Wildlife Endangered Species Office. The regional director should establish and maintain a regular censusing program of all sites selected for protection. Census should be conducted by an experienced malacologist, using the procedures described in Frest (1981, 1982) to guarantee consistent estimates.

2.2 Life History. Several aspects of the species' life history, including temperature and humidity tolerances, breeding conditions, diseases, life span, and a precise minimum viable population size, require further elaboration.

2.3 Forage Preferences. This aspect of the species' biology is as yet imperfectly known.

2.4 Determine effects of environmental contaminants on snail populations. Frest (1982) has documented the possible deleterious effects of pesticides and herbicides on snail populations. Thorough research on this possibility is needed.

2.4.1 Conduct toxicity tests on surrogate species. Investigation of the effects of toxic agricultural chemicals on the snail should be attempted. Although this is not well documented, it is believed to be a factor in snail extirpation at some sites. It may prove an increasingly important problem in the future given the extent of chemical usage in the species' range.

2.4.2 Monitor colony sites for evidence of pesticide or herbicide contamination.

2.4.2.1 Forage Plants. If colony mortality is noted, samples of forage plant species in the immediate area should be collected and analyzed.

2.4.2.2 Sample Snails. In cases of unusual colony mortality, bioassay of survivors or dead animals (rarely available) should be made for toxic chemicals.

2.4.2.3 Sample Soil. As in the preceding circumstances, soil analysis may be necessary if the toxic chemical source is groundwater contamination.

2.4.3 Conduct studies for potential ground water contamination. Because algific slopes are connected to ground water systems involving subsurface water transport and surface entrances to fissures and caves in a karstified region, the effects of chemical contamination of local ground water should be investigated.

2.5 Reestablish snail colonies. Because the existing population is small and not enough additional inhabited sites may be discovered, reintroduction should be considered.

2.5.1 Maintain Laboratory Breeding Colony. To provide material for reintroduction, and also to reduce collection and research pressures on natural populations, a laboratory colony should be maintained. Culture methods are easy and inexpensive (Frest, 1981). Selection of ten individuals from a large colony should be sufficient to establish breeding stock, although more may be desired from a genetics standpoint. Enough material should be available within three years of start-up to permit reintroduction.

2.5.2 Identify suitable reintroduction sites. Available data from Frest (1981, 1982 and in prep.). Potential and proven habitats are noted in Figure 4, and Appendix III details survey progress. Enough colonies may exist to permit change to threatened status, so high priority should be given to this item.

2.5.3 Appropriately protect reintroduction sites. Sites for reintroduction can be evaluated and protected using the procedures in item 1.4 and 1.5.

2.5.4 Reintroduce snails. Because snails travel relatively short distances and more or less at random, the precise location and date of plant at each reintroduction site should be marked by a sign. Lots of 100 or so individuals, closely spaced, should be planted in suitable habitat.

2.5.5 Monitor reintroduction sites. The subsections of item 2 are relevant here. Periodic sampling at regular spatial as well as times intervals should be attempted to determine the rate of spread.

2.6 Law enforcement monitoring of colony sites. Both the Law Enforcement Division of the U. S. Fish and Wildlife Service and appropriate state conservation agency personnel should cooperate in an effort to monitor colony sites periodically and investigate violations.

2.7 Geologic History. Further investigation of the species' geologic history, migration patterns, and past occurrences may clarify its relict status and indicate factors responsible.

3. Information and Education

3.1 Insure information transfer to appropriate government agencies. Officials at all governmental levels should be informed as to the historical and biological significance of glacial relicts. The historical oddity of the sites should be emphasized, as well as the essential harmlessness and freedom from disease of the snail species. To identify potential conflicts necessitating Section 7 consultations or involving local planning actions, lists of locations and extent of colony sites should be provided to appropriate Fish and Wildlife Service offices and state agencies.

3.2 Provide information on status of snail and its requirements to landowners of colony sites. Surrounding landowners should be encouraged to leave adjacent property in a natural state, i.e., forested, where possible. Emphasis on the sites themselves as a unique part of the area's natural heritage and on the animal's glacial history and significance may be helpful.

3.3 Slide program and written literature. A color slide program and well prepared pamphlet should be made available to parks, preserves, and nature centers located in the Driftless Area. Particular effort should be made to inform spelunkers, scout troops, organized conservation groups, etc., in the affected states. The purpose of both presentations would be to convince the public of the importance of protecting the snail and algific sites, and to underscore the need for the public's cooperation to make the protection effort successful.

3.4 Ranger-naturalist talks. All agencies conducting natural history programs within the Driftless Area should be encouraged to include information on the Iowa Pleistocene snail in their programs and, if needed, provided with the materials developed in items 3.3. These include state and county parks, nature centers, national monuments, the Corps of Engineers, and nature conservancy and natural heritage programs in the affected area.

PART III

Implementation

Priorities in column four of the following implementation schedule are assigned as follows:

1. Priority 1 - All actions that are absolutely essential to prevent extinction of the species.

2. Priority 2 - All actions necessary to maintain the species' current population status.

3. Priority 3 - All other actions necessary to provide for full recovery of the species.

RECOVERY PLAN IMPLEMENTATION SCHEDULE

Iowa Pleistocene Snail

GENERAL CATEGORY	PLAN TASK	TASK #	PRIORITY #	TASK DURATION	RESPONSIBLE AGENCY FWS REGION	RESPONSIBLE AGENCY FWS PROGRAM	RESPONSIBLE AGENCY OTHER	FISCAL YEAR COSTS (EST.) FY 84	FY 85	FY 86	CMTS/ NOTES
I 2	Survey for new sites	1.1	2	2 years	3	SE	IL, IA, WI, MN		5,000	5,000	Wis. survey FY 83
I 3	Determine buffers	1.2	2	2 years	3	SE	IL, IA, WI, MN		5,000	5,000	
M 7	Protect sites on public land	1.3	2	1 year	3	SE			8,000		
A 1-3 & 6	Protect privately owned sites	1.4	2	1 year	3	SE	IL, IA, WI, MN		2,000		
M 7	Habitat protection	1.5	1	2 years	3			5,000	5,000		
I 1	Monitor populations	2.1	2		3	SE	IL, IA, WI, MN	1,000	1,000	1,000	
R 3	Life history and forage studies	2.2 2.3	2	1 year	8	Res.			3,000		
R 12	Determine effects of environmental contaminants	2.4	2	1 year	8	Res.				5,000	
M 2	Reestablish snail colonies	2.5	3	3 years	3	SE	IL, IA, WI, MN		9,000	6,000	
O 2	Law enforcement	2.6	2		3	LE		2,000	2,000	2,000	
I 6	Investigate geologic history	2.7	3	1 year	8	Res.				5,000	
O 3	Inform agencies	3.1	3	1 year	3	SE		2,000			
O 1	Inform landowners	3.2	3	1 year	3	SE	IL, IA, WI, MN	2,000			
O 1	Inform public	3.3 3.4	3	1 year	Pg 24					3,000	

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R(Research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

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APPENDIX I. Midwest Discus species

Four extant and one extinct (possibly surviving as a relict) Discus species occur in the Driftless Area. Some salient morphologic features are compared in the accompanying table (3). Ecology and field identification marks (in comparison with D. macclintocki) are discussed narratively here.

Discus patulus is slightly larger but has slightly fewer whorls (5 1/2). The very wide umbilicus, cinnamon brown coloration, lower spire, and coarse ribs on both the top and base of the shell are distinctive. The species is near the north and west peripheries of its range here. In Iowa, it prefers moist upland woods and wooded slopes in limestone terrains, is extremely patchy in distribution, and is found in rotting deciduous logs and under bark, especially of basswoods and maples. The animal is white. It does not occur on algific slopes.

Discus cronkheitei is smaller, loosely coiled (4 1/2 whorls at most), and less elevated. The tan to greenish brown shell has a narrower umbilicus and also has fine ribs on the base of the shell. The whorl peripheryy is broadly rounded. The animal is generally grey. The species is found in most of North America. In the Driftless Area it is found mostly along stream bottoms and on flood plains, wooded or not. It is not a calciphile. The species is not usually found on slopes or uplands, but is often found on algific slopes and sometimes occurs with D. macclintocki. It feeds on a variety of green and dead plant and animal matter. It is a common fossil species in the same areas.

Discus catskillensis is the smallest species. It generally resembles D. cronkheitei but has a slightly wider umbilicus and subangular whorl periphery; the color of the Driftless Area specimens is distinctly reddish brown. Basically a northern species (northeast U. S. to northernmost Michigan, Minnesota and South Dakota), it is present only as a fossil or as relict populations on algific talus slopes or sandstone outcrops in the Driftless Area. Currently less than twenty populations are known, mostly associated with D. macclintocki or on outcrops of the St. Peter Sandstone.

Discus shimeki is basically a Rocky Mountain form that was widespread in the upper Midwest until fairly recently (ca. 10,000 YBP). It may still survive as a relict form in the Driftless Area. A comparatively narrowly umbilicate form with evenly rounded body whorl, it is higher spired than D. macclintocki, but also smaller and with fewer whorls. The ribs are rather fine to obsolete above and essentially absent below. The yellowish-green shell and light grey animal in live examples are quite different from all except macclintocki. Fossil shells often display faint color patches on the upper part of each whorl. The species prefers cold arid climates. In the Rockies the species favors seasonally moist relatively open ground on forested mountain slopes and is often found on calcareous soil or outcrops. Farther north and east the species is found on open ground near streams or wet areas. Wisconsin loess and late glacial-early Holocene alluvial terrace snail faunas are often dominated by this species in the upper Midwest.

Discus macclintocki, though just smaller and higher than patulus, is much larger than the remaining species, and less narrowly umbilicate. It is the most tightly coiled, and the bicolored animal (light grey ground color with upper body streaked with darker grey behind the upper tentacles) is also distinctive. The adult shell has about 6 whorls and can be either horn or yellow-green in color.

Table 3

Major morphologic features of Upper Midwest Discus species.

TAXON	RIBS	WHORL PERIPHERY	SHELL COLOR	UMBILICUS	DIAMETER	SPIRE	WHORLS
patalus	coarse top and base	rounded	cinnamon-brown	wide	7-9 mm	depressed	5 1/2
macclintocki	fine, top only	flatly rounded	brown or greenish white	moderate	6-8 mm	moderate	6-6 1/2
cronkheitei	fine, top and base	subangular to rounded	tan to greenish brown	small	5-7 mm	depressed	3 1/2-4 1/2
catskillensis	fine, top and base	angular	reddish brown	moderate	4-5 mm	depressed	4
shimeki	faint, top only	evenly rounded	yellowish-green	narrow	6-7 mm	low conic	4 1/2

APPENDIX II. Distributional History

The Iowa Pleistocene snail appears abruptly in the geologic record approximately 400,000 YBP. Origins, total age and geographic range, and relationships are obscure for a variety of reasons. Anatomy does not indicate a close relationship to either D. patulus or D. cronkheitei. The pre-Wisconsinan fossil record is spotty, except in Illinois, and Holocene (post-glacial, pre-modern) sites are uncommon. Nevertheless, a brief history is possible and desirable, as it explains much of the oddity of present scattered occurrences.

Most fossil sites are in wind-blown (aeolian) silts, termed loess, along major river valleys in the upper Midwest. The species is common only in deposits formed during glacial advances when the climate was much more severe than at present. Presumably during interglacials such as the present, the species retreated to relictual areas. Because of the widely varying pattern of ice advance in each glacial, relict areas were probably different each time. The Iowa Pleistocene snail population has waxed at least three times (Kansan, Illinoian, and Wisconsinan) and waned during at least four interglacials.

Kansan records are limited to a few counties in central Illinois (Figure 5). Judging from the extent of the Kansas ice sheet, the species was minimally present in Indiana and Missouri and possibly also in Kentucky and Ohio; few Kansan snail localities have been described from this interval. The species was more widely distributed in Illinois during the Illinoian (Figure 5), and certainly should occur in Illinoian loesses in Iowa, Missouri, and Indiana also. The record is rather more complete for the last glacial, the Wisconsinan. Numerous sites are known from Illinois and Missouri with a few also in Nebraska, Iowa and Ohio (Figure 5). Based on reconstructed snail biomes (Frest and Fay, 1980) and other data, the likely total Wisconsinan range has been reconstructed as shown in Figure 6; areal extent for other glacials was probably comparable. The more complete record for the Wisconsinan is due to the widespread occurrence of the so-called Peoria Loess (Woodfordian) throughout the central U.S.. Whereabouts of the species during all interglacials except the current one is a mystery. With the waning of glacial climates, the species should have migrated to follow the retreating ice sheet until stopped by overly harsh normal northern winters. Survival was dependent upon the occurrence of suitable relict habitat in the territory intervening between maximum glacial advance and the "normal" (i.e., interglacial) - 40°C isotherm (Frest, 1982). As areas covered by thick glacial deposits are unsuitable for the formation of algific slopes, only relatively unglaciated areas near the glacier's line of retreat offered possibilities. Very likely, the areas inhabited by D. macclintocki during earlier interglacials are now covered by younger glacial deposits. Similarly, the area occupied during an interglacial would be unsuitable (too cold) during the preceding glacial advance, even though not itself glaciated. Thus, a peculiar combination of improbable circumstances is necessary to provide the species with an interglacial refugium, and it is inherently unlikely that the refugial area will be as extensive as the normal glacial range.

While it is possible that the long-unglaciated Driftless Area has more than once been a refugium, there is as yet no evidence. As far as can be told, algific talus slopes probably formed about 18,000 YBP (Frest, 1982, Appendix IV). The earliest record for D. macclintocki in the Driftless Area is from an approximately 20,000 YBP colluvial site in Clayton County, Iowa. The species was probably pushed to the south for the next few thousand years by the severe climates of the Wisconsin glacial maximum (18,000 YBP). Climates probably did not ameliorate enough to allow migration into the area, and establishment of the present distribution, until the close of the Wisconsinan, about 10,000 YBP. The Iowa Pleistocene snail is absent from Driftless Area Peoria Loess sites (age ca. 18,000 - 12,000 YBP) or slightly younger Zwingle terrace sites (age ca. 10,000 YBP), which do contain abundant D. shimeki and D. cronkheitei. There are a few undated Holocene sites in Iowa and Illinois (Figure 5D); typical is a fissure site in Jackson County, Iowa, just within the border of the Driftless Area, with abundant D. macclintocki, that is believed to be between 8,000 and 10,000 years old (B. Rosenberg, pers. comm. 1983).

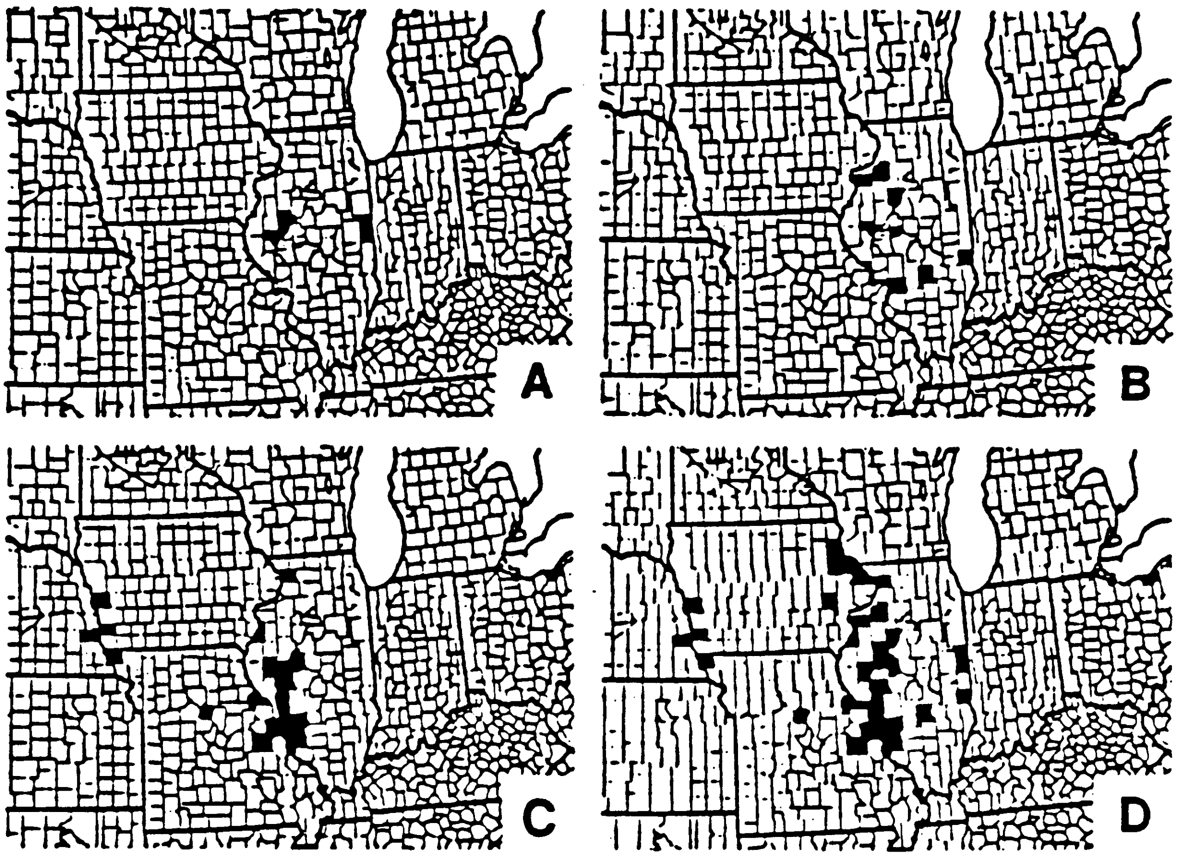

Figure 5. Distribution by county of D. macclintocki sites. A, Kansan; B, Illinoian, C, Wisconsinan, D, all records, including Holocene

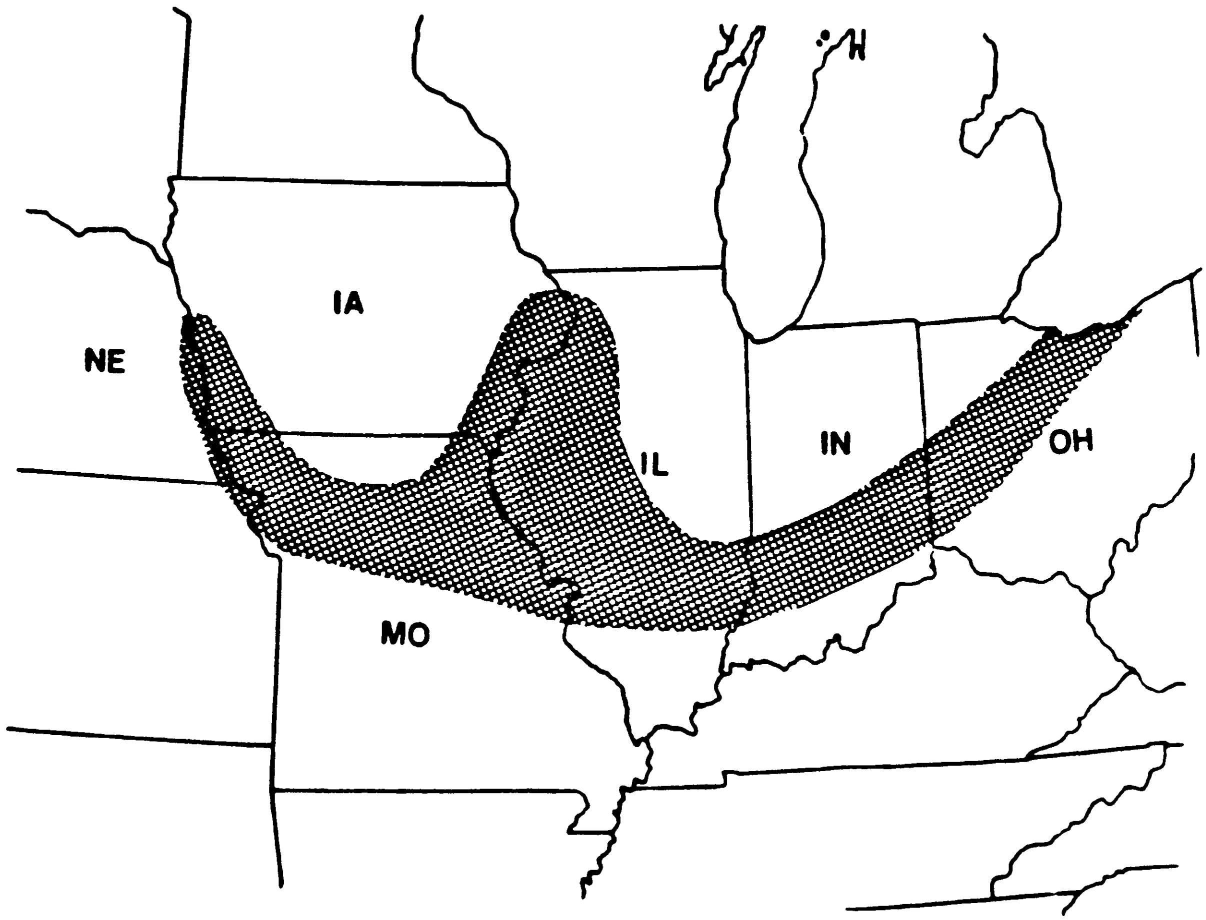

Figure 6. Approximate Wisconsinan (Woodfordian) range of D. macclintocki during Peoria Loess deposition (ca. 18,000 - 12,000 YBP).

APPENDIX III. Status of Habitat Survey

As of January 1983, approximately one half of that portion of the Driftless Area and surrounding territory believed to have the potential to maintain algific slopes (Figure 7) remains completely unsurveyed. Surveying activities in those portions which have been visited are about 80 percent complete. To facilitate review, status and recommendations are analyzed by state below.

1. Iowa. Of the approximately 200 known aligific slopes, roughly 160 are located in Iowa (Frest, in prep., 1982). About 150 are evenly split between the Galena and Hopkinton, which have extensive Iowa outcrop areas (Figure 8). The Prairie du Chien, with little areal outcrop extent in Iowa, has few (*ca.* 10). Some field work has been done in most of the Iowa Driftless Area; with a total expenditure of eleven weeks field time, I regard the survey as about 80 percent complete. Approximately four weeks more are required. As this area includes all but one of the known sites, it should be given high priority.

2. Minnesota. About 20 sites, all but one discovered in 1982 and 1983, are known (Frest, in prep.). Most of these are in the Galena outcrop area; a few are in the largely unsurveyed Prairie du Chien outcrop belt. The surveyed area (three weeks) has about one-third coverage. A sketchy survey of the whole Minnesota potential area would require about 4 weeks; it is in very difficult terrain. The high potential area is about two-thirds the size of the proven Iowa algific slope area. Complete survey would require two months.

3. Wisconsin. With a potentially suitable area equal to that of Iowa, about two thirds, mostly in the Galena outcrop belt, has been surveyed (four field weeks) and that portion is now three quarters complete. Full survey of the Galena area would require about four weeks; the Prairie du Chien segment would require a similar time period. At present about one dozen algific slopes are known in Wisconsin, all discovered subsequent to Hartley (1962) in 1981 and 1983 (Frest, in prep.).

4. Illinois. The small Illinois Driftless Area has never been systematically surveyed for algific slopes. One was, however, recently reported (J. Schwegman, pers. comm.), and a recent visit in March 1983 confirms that it is an algific slope.

   Suitable terrain exists in parts of three Illinois counties (Figure 7). Illinois lacks a Prairie du Chien outcrop belt, but has representation of the approximate Silurian (Hopkinton, Blanding, Tete des Mort and equivalents) and upper Ordovician (Galena Group) section (Figure 8). About three weeks of field work would be required to survey this area.

   Frest (in prep.) determined that a number of algific slopes do exist in Wisconsin and Minnesota, and that a number of these are florally similar to the Iowa slopes. Although no D. macclintocki colonies were located, several slopes do have the other glacial relict species, especially Vertigo, and it is quite possible that these states may have D. macclintocki. Certainly, some sites in each have good potential as areas for reintroduction.

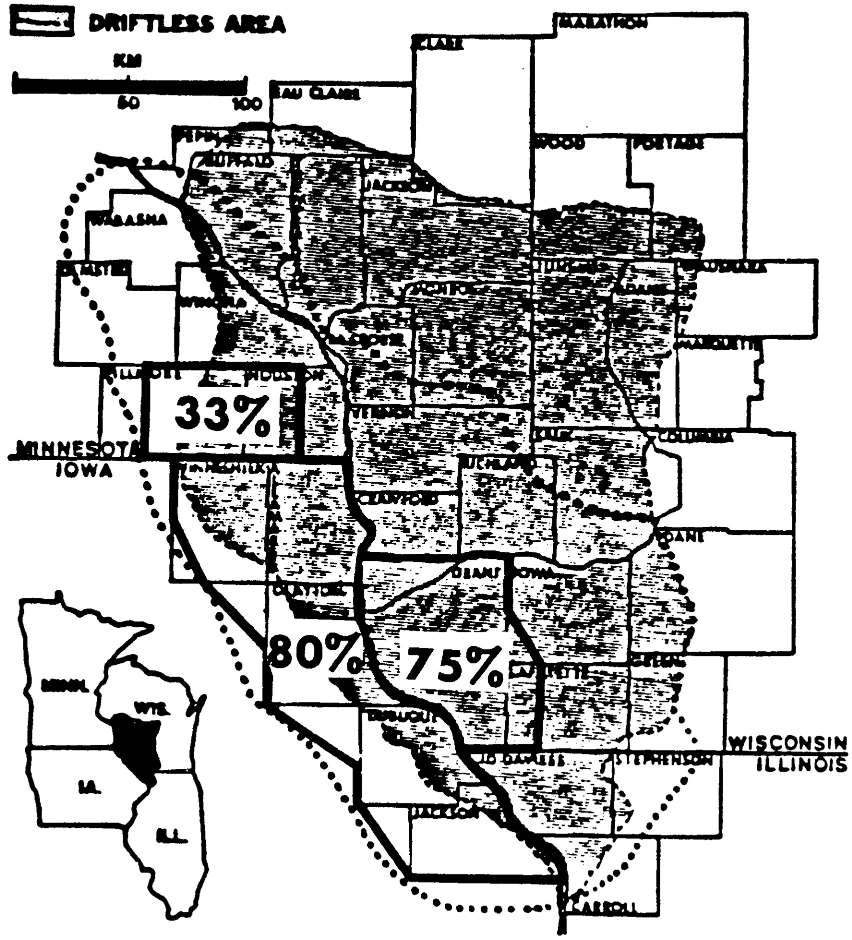

Figure 7. Survey status for Iowa Pleistocene snail. Dotted line surrounds area with good potential for algific slopes. Heavy black lines indicate areas in which survey has been attempted: percentage figures indicate estimated degree of completeness.

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