A survey of the molluscan fauna of a mixed farm in South County Cork, 2004

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Cover photo: Glinny-Boulaling Farm (© Evelyn Moorkens)

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1. Introduction

A case study farm in south County Cork has been surveyed for molluscs. The study farm (Glinny-Boulaling Farm) has been the subject of a number of ecological investigations, and the site history and management over the last 70 years have been well documented (Good, 2001). Inventories have been made of vertebrates, dragonflies, syrphids and sciomyzids within the farm area (Good, 2001, Speight, 2001). Of particular interest was the contribution made by various habitats and groups of habitats within the farm to the biodiversity of these groups, including an assessment of which elements of these faunas would be predicted to be lost if various changes were made from the current use of the land (Good, 2001, Speight, 2001, Speight & Good, 2001). The molluscan fauna of the farm was studied with a view to assessing the contribution of the habitat groups present to the biodiversity of the land and freshwater snails and slugs.

2. The Case Study Farm

Glinny-Boulaling Farm is situated in an undulating landscape on Devonian Old Red Sandstone, overlain by glacial till (Good, 2000). There are two main soil types: well drained brown podzolic soils are present on the sloping areas, and these areas are used for grassland and cereal crops, and gley soils are found in the restricted drainage areas at the bases of these slopes, where the habitats are semi-natural with flushes, carr and scrub present. Although limestone has been applied over the years to increase soil fertility, there is no part of the farm that is naturally calcareous. The farm has a considerable range of hydrological variation. As well as the topographical differences in drainage, there is also a series of non-calcareous springs that result in flushing areas within the *Molinia* wetland, and result in very wet areas of *Alnus* carr. One of the farm tracks forms a watershed division between two small streams. The farm is 41.8 hectares in area, approximately one fifth of which can be considered to be semi-natural, and the rest of which is divided into 14 field units, the majority of which are in grassland, either grazed or cut for silage. The largest, most south-westerly field was under a cereal crop during the study.

3. Approach to the Molluscan Study

There is considerable literature available on molluscan biodiversity in general, but most of the studies and publications to date on Mollusca in farms have concentrated on the control of pest species, mainly slugs, as these can cause economically significant losses, particularly in the early stages of crop growth (e.g. Glen *et al*, 1994; George *et al*., 1995). The study of the Glinny-Boulaling farm for Mollusca was designed to divide it into as many different molluscan habitat areas as possible, in order to ascertain the contribution to biodiversity that each component makes.

The habitat components largely divide into field units in productive use, their associated infrastructure, and areas that can be considered Disused, either due to being too wet to merit intensification, or margins that have been retained in a semi-natural state as boundaries. The older infrastructural areas have developed a semi-natural flora, thus categorising some of the more natural field boundaries presented some difficulties. In general, all walls, banks and ponds were considered to be Infrastructure Used, while all well-established hedges and tree lines were defined as Infrastrusture Disused.

Thus, the habitats were categorised as follows:
> Productive
> Infrastructure Used
> Infrastructure Disused
> Disused

The sampling methodology was designed to allow comparison between sampling by hand and by vegetation removal, the lack of similar studies suggests that this information would also be useful in the wider sense.

4. Methodology

4.1 2000 survey

A brief molluscan survey of the farm was first carried out on 5th June 2000. This consisted of removing a 2.5l bag of vegetation from each of 10 different areas of the farm. The samples were dried and then sieved through a series of mesh sizes, the lowest being 0.5mm.

4.2 2004 survey

The 2004 survey of the farm Mollusca included sampling visits between 11th and 14th March, from 30th April to 4th May, and on 29th and 30th June 2004.

A total of 49 sites were investigated during the study, sites were not repeatedly sampled, but were surveyed during one of the visits.

In the productive fields, and barn interiors where no vegetation occurred, a hand search of the area for 30 minutes (two workers for 15 minutes each) was carried out.

Aquatic habitats were sampled using an extendable, robust, aluminium-framed, pond net (handle and frame 2.4m in length, equipped with a 0.5mm nylon mesh bag). Both the bivalves (which mainly live in the sediment) and the gastropods (which mainly live on the weeds) were collected. At each sampling point the net contents were amalgamated into a bucket. The sample was agitated in water to release snails from the weed, allowed to settle, and then snail-free vegetation was removed. The samples were examined in the field by tipping the molluscs into a white tray, and the large bivalve and gastropod species present were recorded. The remainder of each sample was placed in labelled self-seal bags and examined microscopically in the laboratory, while still alive, over the following days.

At the rest of the sites, a hand search of the area for 30 minutes (two workers for 15 minutes each) was carried out, and a vegetation sample was removed. The vegetation

sampling consisted of plucking low vegetation and litter from the study site, shaking over a tray and discarding the large leaves, until approximately 3 litres of fine litter was collected. The resulting litter was dried, sieved through a series of mesh sizes, the lowest being 0.5mm, and the snails collected in each sieve were identified. Nomenclature follows Moorkens & Speight (2001).

In order to put the farm molluscan fauna into context, the species list is compared with the list of species known to occur in Cork, according to the Republic of Ireland molluscan database of records. Comparisons are also made with a 25 hectare (approx.) Cork woodland (Ballyannan Wood, near Middleton) in June 2003, and a typical mature Cork Garden (Victoria Terrace, Glenbrook) in June 2004, approximately 40m² in area.

5. Results

The areas surveyed and the results of the one day survey in 2000 are shown in Tables 1 and 2. The full site descriptions from the 2004 survey, including classification into disused, infrastructure or productive categories, are given in Appendix 1. The molluscan species found in both the field and litter sampling are given in Appendix 2. Of the farm's total fauna of 57 species, 51 were found by field searching, 30 species were found in litter samples and 9 species were found in the aquatic habitat samples. The sixteen species of slug were found only in the field as were 5 species of terrestrial snail. Six species of aquatic gastropod and bivalve were found only in the aquatic habitat samples.

Two species (*Columella aspera* and *Vitrea contracta*) were found only in the litter samples. Other species which were found predominantly in litter rather than in the field were: *Nesovitrea hammonis* (5 of the 6 records were from litter), *Euconulus fulvus* (4 out of 5), *Vitrina pellucida* (3 out of 4), and *Leiostyla anglica* (3 out of 6). Three further species, *Balea perversa, Aegopinella pura* and *Oxychilus cellarius* were also recorded frequently in the litter samples.

A map of the farm showing the sampling sites is given in Figure 1.

The total of 57 species of Mollusca were found on the farm during the study (Table 3) compares with 159 species of mollusc in Ireland, and 121 in County Cork. The mixed woodland habitat at Ballyannan Wood had 34 species of mollusc, while the mature back garden at Glenbrook had 18 species (Appendix 3).

Table 1. Locations of samples taken during one day general survey, 5th June, 2000

| Sample	Area of farm
1	Stream / drain at Long Bog W 6687 5855
2	Wet flush at Snipe Bog W 6676 5852
3	Feed Barley field – Pairc Giol W 6677 5866
4	Wet Alder wood "The Screen" W 6663 5870
5	Pig Bog including aquatics W 6648 5872
6	Uncut area near 5, *Juncus effusus, Holcus lanatus, Iris*, Brambles
7	Nearby 5, irregularly cut, mostly *Holcus lanatus, Ranunculus arvensis* – Mat left behind after cutting
8	Nearby, in enclosed experimental section with annual cut – Mat removed after cutting
9	The big pond W 6658 5891
10	The small pond (more enriched) W 6656 5893
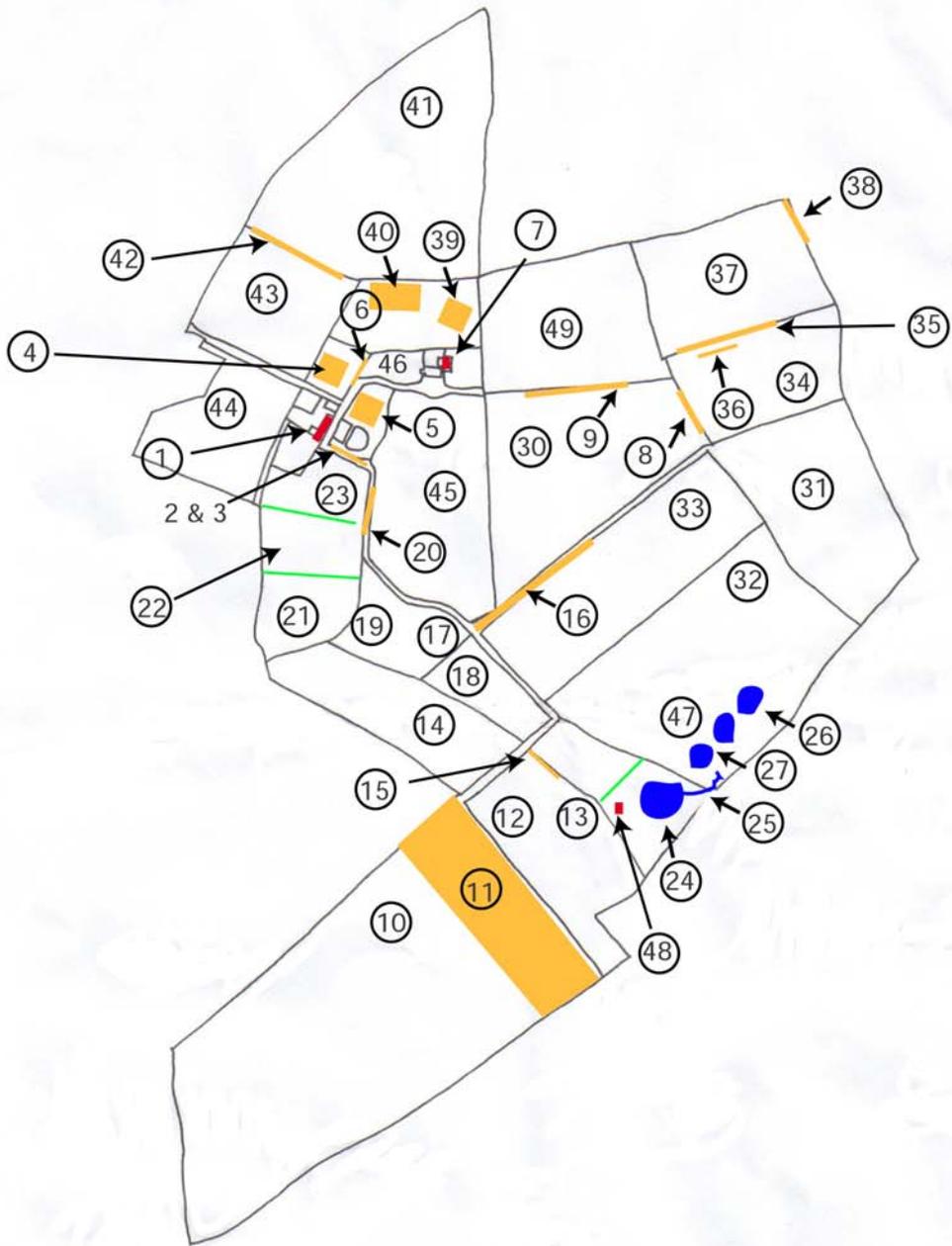
Figure 1: Glinny Boulaling Farm sample locations

Table 2. Species found in 10 sample sites during one day general survey, 5th June, 2000

Species	1	2	3	4	5	6	7	8	9	10
Potamopyrgus antipodarum	X	X			X				X	X
Carychium minimum		X								
Lymnaea truncatula									X	
Lymnaea palustris									X	X
Lymnaea peregra									X	
Anisus leucostoma		X								
Gyraulus albus		X							X	
Hippeutis complanatus					X				X	X
Oxyloma pfeifferi	X									
Cochlicopa lubrica					X		X			
Columella aspera		X								
Vertigo antivertigo		X								
Discus rotundatus				X						
Arion hortensis							X			
Nesovitrea hammonis							X			
Aegopinella pura		X								
Aegopinella nitidula				X						
Oxychilus draparnaudi					X					
Zonitoides nitidus					X		X	X		
Milax gagates			X							
Deroceras reticulatum							X			
Clausilia bidentata				X	X	X	X			
Trichia striolata										X
Cepaea nemoralis				X						
Pisidium personatum	X	X		X						
Pisidium casertanum	X	X		X					X	X
Pisidium obtusale									X	X
Total no. species – 27	**4**	**9**	**1**	**6**	**6**	**5**	**6**	**1**	**8**	**6**

Table 3: The farm fauna in context

	Ireland	Cork	Study farm
Freshwater & brackish water gastropods	40	26	7
Freshwater bivalves	21	13	5
Land snails	68	54	29
Land slugs	30	28	16
Total	**159**	**121**	**57**

Table 4: Mollusc species ordered in frequency of occurrence
(D=Disused, ID=Infrastructure disused, IU=Infrastructure used, P=Productive land)

Rank	Species	Habitat	No. of occurrences	D [12]	ID [6]	IU [16]	P [15]
1	*Deroceras reticulatum*	Ubiquitous slug – pest species	32	7	6	6	13
2	*Clausilia bidentata*	Catholic shaded habitat snail	26	10	6	10	
3	*Discus rotundatus*	Catholic shaded habitat snail	23	10	6	7	
4	*Oxychilus cellarius*	Catholic shaded habitat snail	21	9	5	7	
5	*Cochlicopa lubrica*	Catholic damp, shaded habitat snail	18	7	5	5	1
6	*Lauria cylindracea*	Dry habitat snail	17	4	6	7	
7	*Arion ater/rufus*	Catholic slug	17	7	1	5	4
8	*Trichia striolata*	Catholic snail, hedgerows, grassland	17	3	5	8	1
9	*Aegopinella pura*	Catholic shaded habitat snail	16	6	5	5	
10	*Arion subfuscus*	Catholic slug	14	5	2	5	2
11	*Arion distinctus*	Catholic slug	14	3	1	6	4
12	*Aegopinella nitidula*	Catholic shaded habitat snail	13	3	4	6	
13	*Pisidium personatum*	Aquatic poor habitat bivalve	11	8		3	
14	*Balea perversa*	Walls and trees, indicator of better quality habitat	11	2	4	5	
15	*Cepaea nemoralis*	Hedgebank/grassland snail	10	3	1	6	
16	*Galba truncatula*	Aquatic poor habitat gastropod	10	5	1	3	1
17	*Deroceras panormitanum*	Slug - generally associated with synanthropic habitats	10	2	4	4	
18	*Arion flagellus*	Introduced slug, becoming widespread	8			5	
19	*Ashfordia granulata*	Generally open habitats, walls, wetlands	8	0	4	4	
20	*Tandonia budapestensis*	Pest slug	8			5	3
21	*Carychium minimum*	Wetland snail	7	5	2		
22	*Limax maculatus*	Damp, shaded habitats, woodland, buildings	7	2	3	2	
23	*Potamopyrgus antipodarum*	Aquatic catholic gastropod	6		2	4	
24	*Leiostyla anglica*	Damp, shaded habitats, indicator of better quality habitat	6	3	3		
25	*Zonitoides excavatus*	Calcifuge snail, wet and shaded habitats	6	6			
26	*Nesovitrea hammonis*	Catholic snail, wetlands, often very poor habitats	6	5	1		
27	*Oxychilus alliarius*	Catholic snail, generally dry, shaded or acid places,	6	2	1	3	
28	*Lehmannia marginata*	Arboreal slug	6	3	2	1	
29	*Deroceras leave*	Wetland slug	6	6			
30	*Arion intermedius*	Catholic slug	5	4	1		
31	*Zonitoides nitidus*	Wetland snail	5	5			
32	*Euconulus fulvus*	Shaded damp/dry habitats	5	4	1		
33	*Oxychilus draparnaudi*	Snail - generally associated with synanthropic habitats	5		1	4	
34	*Milax gagates*	Slug, open habitats	5				5
35	*Physella acuta*	Aquatic gastropod - introduced species!	4			4	
36	*Cochlicopa lubricella*	Grassland snail	4	2		1	1
37	*Columella aspera*	Fens and woodlands, often rather acid habitats	4	4			
38	*Arion circumscriptus*	Catholic slug	4		2	2	
39	*Vitrina pellucida*	Catholic snail - grassland, hedgerows etc	4	1		3	
40	*Pisidium casertanum*	Catholic aquatic bivalve	3			3	
41	*Arion silvaticus*	Slug - damp, shaded habitats habitats	3	2		1	
42	*Vitrea crystallina*	Wetland snail	3	3			
43	*Helix aspersa*	Snail - buildings, hedgerows, requires calcium element	3			3	
44	*Anisus spirorbis*	Aquatic snail - ephemeral habitats	2	2			
45	*Hippeutis complanatus*	Pond gastropod	2			2	
46	*Oxyloma pfeifferi*	Wetland snail	2	2			
47	*Punctum pygmaeum*	Catholic snail - damp or shaded habitats	2	1	1		
48	*Candidula intersecta*	Dry habitat snail, requires calcareous places	2	1		1	
49	*Pisidium obtusale*	Pond/swamp bivalve	2	1		1	
50	*Pisidium milium*	Pond/swamp bivalve	2			2	
51	*Boettgerilla pallens*	Introduced slug, becoming widespread	2		1	1	
52	*Stagnicola fuscus*	Aquatic snail - ephemeral habitats	1		1		
53	*Radix balthica*	Catholic aquatic gastropod	1	1			
54	*Vertigo pygmaea*	Grassland snail	1	1			
55	*Vitrea contracta*	Grassland/woodland snail	1			1	
56	*Pisidium subtruncatum*	Bivalve, usually in flowing water	1			1	
57	*Limax flavus*	Slug - usually associated with synanthropic habitats	1			1	

6. Discussion

The results of this study are discussed from a number of viewpoints. The frequency of occurrence and contribution of habitat categories to molluscan biodiversity, the importance of the farm in the context of regional biodiversity, and the potential for management changes to affect this biodiversity are discussed, as well as sampling methodologies and intensity of sampling required to get a true indication of the biodiversity present.

6.1 Species composition of the farm molluscan fauna

The 57 species found during course of the farm survey represent 47% of the known molluscan fauna of Cork. This is a surprisingly high figure, considering that the farm has no major river flowing through it, has no marine influence, and is not a calcareous environment. Therefore many molluscan species could not occur there. Unsurprisingly, the slug fauna has the highest representation, with the farm supporting 57% of the County Cork slug species. The 54% representation of land snails is surprisingly high, considering the calcareous requirements of many shelled species, and the more various specialised requirements of others. The poorest representation was of the aquatic species, with 38% of the Cork bivalves being represented, and only 27% of the gastropods. This is unsurprising, however, as the farm freshwater was restricted to a small non-calcareous stream, and a few ponds, some of which were only recently established.

Appendix 4 shows the relative percentages of species found on the farm, compared with those known from Cork and not found on the farm, for a series of traits that are attributed in the molluscan database (Falkner *et al.,* 2001). Although the database associations have been "fuzzy coded" according to the strength of their associations, all species that had any positive association with a trait were counted equally, and categorised as being either on the farm or not. The percentage of those on the farm and those not on the farm were then graphed. The percentages should be viewed from the point of view of the percentage of Cork species found on the farm, out of 100% of species known from Cork, 47% are known from the farm. As the database does not include either slugs or bivalves, the

percentage of the Cork species on the database that are known from the farm becomes 42%. Therefore, as a rule of thumb, if there is no differences between trait preferences of species on the farm and not on the farm, it could be expected that the approximate breakdown between the on-farm and off-farm categories to be in the region of 42:58. Most of the graphs in Appendix 4 follow this breakdown in percentage quite closely, showing that there is no preference for certain trait characteristics on the farm in most categories. However, the graph of shell thickness shows that there is a lower than expected percentage number of snail species with thicker shells. This most likely reflects the lack of calcium on the farm, as the thicker shelled land snails often require calcareous conditions. The graph showing the food source preferences indicates the higher than expected number of species that feed on leaf litter, fungi, epilithic lichens, and mosses. This reflects the role of the semi-natural woodland and tree line habitats, with the wide supply of lichens that would not be found in areas with a higher level of air pollution. The lack of photophilic species on the following graph also reflects the contribution of the same shaded, semi-natural habitats.

## 6.2 *Frequency of occurrence of species*

Table 4 shows the 57 species of mollusc found during the survey ordered by frequency of occurrence. The top ranked species was the slug *Deroceras reticulatum* which was found in 34 of the 49 sample sites. *Deroceras reticulatum,* the grey field slug, is considered to be the most prolific and damaging species of crop and garden plant species in Western Europe (Glen *et al.,*2000). This was followed by three generally catholic, shaded-habitat snails, *Clausilia bidentata* (26 occurrences), *Discus rotundatus* (24), and *Oxychilus cellarius* (21). The number of species for each number of occurrences is shown in the histogram in Figure 2. These results are shown in Figure 3, where the number of occurrences is amalgamated into six groups. These graphs show that of the 57 species, approximately half of the fauna (28 species) was found in five or less sites. Forty three species (75%) were found in ten or less sites. Only 4 species were recorded in 20 or more sites. Although almost one third of the sites surveyed were categorised as productive land, only one of these 4 most common species could be considered a pest.

Table 4 also shows the distribution of occurrences for each species between the four habitat classes (Disused, infrastructure disused, infrastructure used and productive land). This distribution between habitats is summarized in Table 5. Infrastructure habitats supported the highest molluscan diversity with 47 (82%) of the 57 species recorded, of which Infrastructure Disused supported 31 species (54%) and Infrastructure Used supported 40 species (70%). Disused habitats supported 41 species (72%) whereas Productive land supported only 11 species (19%). Nineteen of the species were restricted to only one of the four classes of habitat: 9 in Disused, one in Infrastructure Disused (*Stagnicola fuscus*), 8 in Infrastructure Used and one (*Milax gagates*) in Productive land. Only seven species occurred in all four habitat classes. Along with *Deroceras reticulatum,* 4 other species on the farm, all slugs, could be considered to be pests. They are *Arion distinctus, Tandonia budapestensis,* and to a lesser extent *Milax gagates* and *Arion ater*. This is because these species live around and under soil clods, emerging in damp, humid conditions (mainly from dusk to dawn) to feed on nearby vegetation. The remaining 11 of the 16 slug species on the farm are not capable of survival in soil clods and thus occur in low numbers, if at all, in productive land.

Figure 2: Frequency of occurrence of numbers of species per site
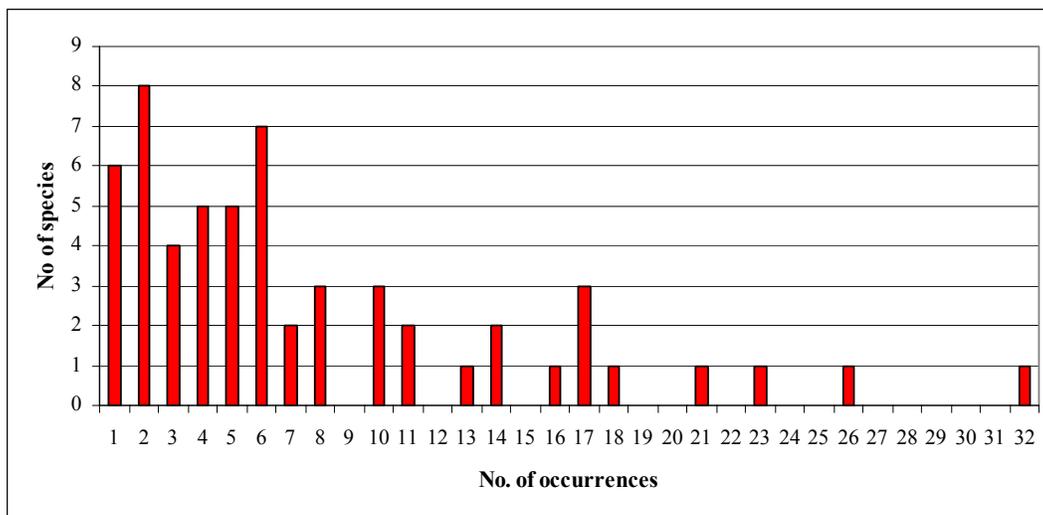
Figure 3: Categorized frequency of occurrence of numbers of species per site
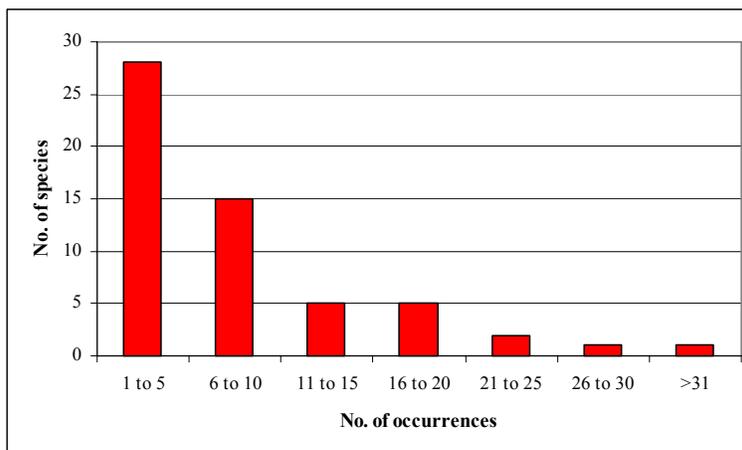
Table 5: Distribution of species between habitat categories

Species occurring in Disused habitats	41
Species occurring in Infrastructure Disused	31
Species occurring in Infrastructure Used	40
Species occurring in Productive land	11
Species occurring in Disused habitats only	15
Species occurring in Infrastructure Disused only	1
Species occurring in Infrastructure Used only	8
Species occurring in Productive land only	1
Species occurring in all 4 habitat categories	7

The number of species recorded from each of the 49 sample sites (ranked in order of mollusc species richness) is shown in Table 6. The number of mollusc species recorded per site ranged from 1 to 23, with a mean of 9 (standard deviation SD 6.4). These results are shown in Figure 4 where the number of species/site is shown as five groups (i.e. 1 to 5, 6 to 10……). This graph shows that 40% of the sites supported 5 or less species, 82% of the sites supported 15 or less species. The top-ranked site (No. 7) supported 23 species, equivalent to 40% of the overall farm fauna. This was due to the fact that this open barn was a transition area incorporating some semi-natural vegetation (i.e. disused habitat category), with infrastructural components, and also with many suitable refugia for molluscs, logs and plastic that have been brought (presumably) from elsewhere, and suitable for the most synanthropic species' survival. The other barn that stands out in

terms of habitat richness is site 1, due to the fact that it provides the most concentrated area of calcium, by virtue of the calcareous mortar used in the barn building. A third of all the farm species were found in the environs of this barn, showing more species richness than all but one of the semi-natural habitats. Other species-diverse, used infrastructure sites include Site 46, the house walled garden and Site 9, a hedge bank with timber/pallet/plastic sack piles. The species-poor used infrastructure sites are those which supported aquatic habitat only, such as the ponds and newly-created wetlands.

The site ranking based upon the number of species/site, with the three main habitat categories colour-coded, is shown in Figure 5. Habitats categorised as Infrastructure support between 2 and 23 species (mean 10.2, SD 6.9). Habitats categorised as Disused support between 4 and 20 species (mean 13.4, SD 3.8), and those categorised as Productive support only 6 species or less (mean 2.5, SD 1.7).

The richest Disused habitats were the wet woodlands such as the alder carr (site 19) and the woodland near the house surrounding the well seepage (site 5). The other damp, relatively mature woodland sites, including the old orchard (site 4) supported over 13 species as did the three sites in Pig Bog, previously divided into experimental grassland sections (sites 21-23). The species-poorer Disused sites comprised the acid fen and scrub habitats.

Figure 4: Categorized number of species/site
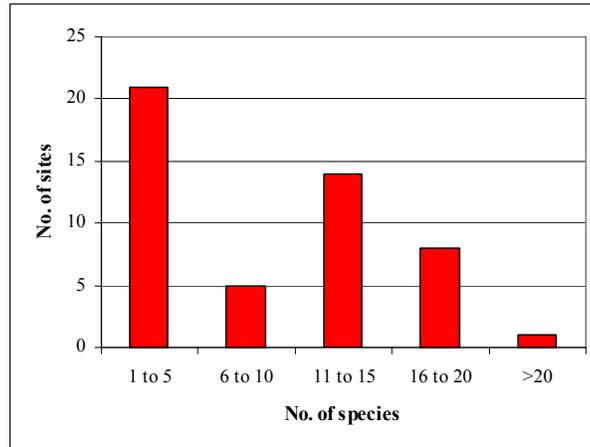
Figure 5: Sites (categorized by habitat) in order of species richness
(blue= Disused, yellow= Infrastructure disused, red= Infrastructure used, green=Productive land)
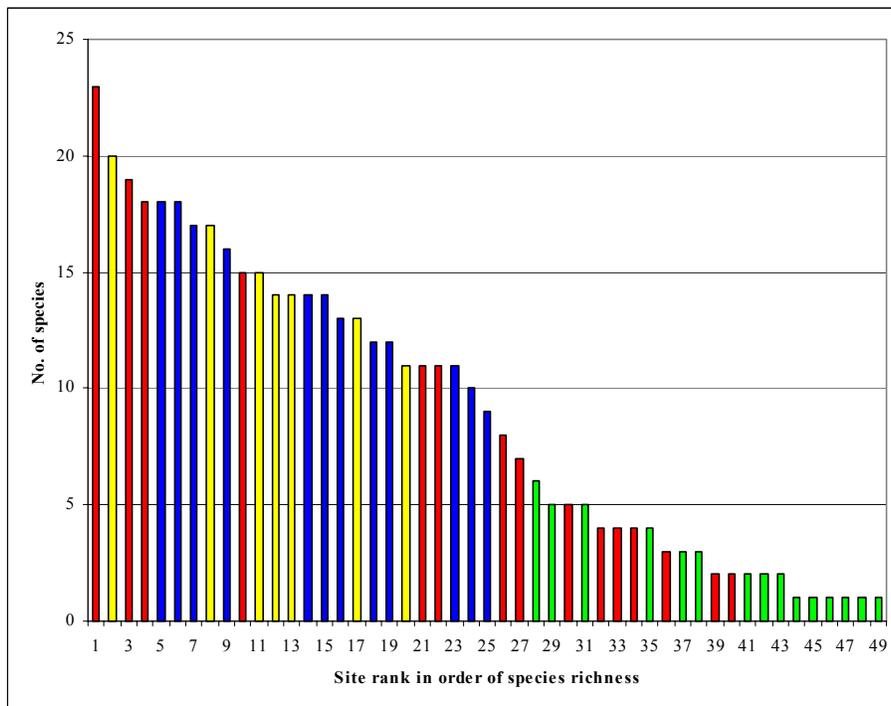
Table 6: Distribution of species between habitat categories
(D=Disused, ID=Infrastructure disused, IU=Infrastructure used, P=Productive land)

Rank	Site No.	Habitat	Category	No. of species
1	7	Barn near house with lots of wood, sacks etc	IU	23
2	5	Woody scrub, old well below farmhouse	ID	20
3	1	Dilapidated stone barn near house	IU	19
4	9	Hedgerow/field margin with lots of old pallets and logs	IU	18
5	19	NW end of alder carr	D	18
6	21	Grassland with *Iris*, lower end of experimental field	D	18
7	23	Upper end of experimental field, grassland with sacks and timber	D	17
8	46	House garden	IU	17
9	40	Elm thicket	D	16
10	8	Hedgerow/field margin	IU	15
11	16	Old hedgerow/track	ID	15
12	2	Wall/hedge, fallen logs near farm	ID	14
13	4	Old orchard near farm	ID	14
14	14	Poor fen and scrub	D	14
15	17	SE end of alder carr (drier)	D	14
16	22	Middle section of experimental field, grassland	D	13
17	42	Margin of field with hawthorn hedge	ID	13
18	12	Poor fen and scrub	D	12
19	18	Poor fen and scrub	D	12
20	3	Margins of well outflow and walls	ID	11
21	6	Wall hedgerow near farm	IU	11
22	39	Grassland with logs, carpets, rubbish etc	IU	11
23	48	Wet poor grassland with *Filipendula* etc	D	11
24	13	Poor fen and scrub	D	10
25	15	Scrub, ditch margins	D	9
26	20	Wall/hedgerow with trees	IU	8
27	35	Bank wall margin of field	IU	7
28	30	Mixed grassland pasture	P	6
29	11	Set aside	P	5
30	28	Lower pond by farm	IU	5
31	44	Hay meadow	P	5
32	24	Newly created pond	IU	4
33	25	Feeder for newly created pond	IU	4
34	29	Upper pond by farm	IU	4
35	31	Pasture	P	4
36	26	Newly created wetland	IU	3
37	10	Barley field	P	3
38	47	Wet grassland	P	3
39	27	Newly created wetland	IU	2
40	38	Hedge margin	IU	2
41	32	Pasture	P	2
42	33	Pasture	P	2
43	49	Pasture	P	2
44	34	Pasture	P	1
45	36	Grassland margin	P	1
46	37	Pasture	P	1
47	41	Pasture	P	1
48	43	Pasture	P	1
49	45	Pasture	P	1

6.3 Similarity analysis of site species lists

The species occurrences at each sampling site were analysed for similarity using the statistical package PRIMER-E.

Figure 6 shows the dendrogram of Bray Curtis Similarity for the molluscan fauna of the 49 sites. There are three clear groupings:

1. The six truly aquatic habitats (farm ponds, artificial ponds and wetlands) which have <20% similarity with the fauna of any of the other sites. These are outlined in red in Figure 6.
2. All of the faunas of sites in productive land with <40% similarity (outlined in dark blue in Figure 6), and
3. All of the faunas of habitats classified as Disused or Infrastructure (Used and Disused).

Within the third grouping, there are seven main sub-groups, five for the faunas of Disused and Infrastructure Disused habitats (outlined in pink in Figure 6), and two for faunas from mostly InfrastructureUsed habitats (outlined in turquoise in Figure 6). The sub-groups for the Disused and Infrastructure Disused sites comprise the following sites/habitats:

a) sites 12, 13, 48 – poor grassland and scrub
b) sites 15, 17 – relatively dry woodland/scrub
c) sites 3, 5, 14, 18, 19 – damp to wet shaded habitats
d) sites 21, 22, 23 – damp grassland (old experimental plots)
e) sites 4, 16, 40, 42 – old, wooded hedgebanks and the elm thicket

The two mostly Infrastructure Used sub-groups divide as follows:

a) sites 1, 7, 8, 9, 46 – buildings, and hedgebanks with timber/pallet/plastic sack piles

b) sites 2, 6, 20, 39 – the first 3 are old mortared walls, the other is a field with 'building waste'

There are a further 2 sites which appear on their own within the main group, sites 38 and 35. Site 38 is <20% similar to any other site in that main grouping. Site 38 is a hedge margin that had only two species of snail, and Site 35 stands out as it has a mixture of species of both bank and wall. This underlines the importance of sampling from as homogenous a habitat as possible in order to understand the basis for the species composition from that habitat.

The Multi dimensional scaling (MDS) plot 7 for the log transformed data is shown in Figure 7. The stress level of 0.09 corresponds to a good ordination with no real prospect of misleading interpretation (Clarke & Warwick 2001). The results of the MDS ordination also reveal the three main groupings shown in the Bray Curtis dendrogram (Figure 6). However, the Disused habitat sub-group with sites 12, 13 and 48, i.e. the wet grassland habitats, are further away from the main Disused/Infrastructure habitat cluster. Site 38 again stands out as being different from the main group.
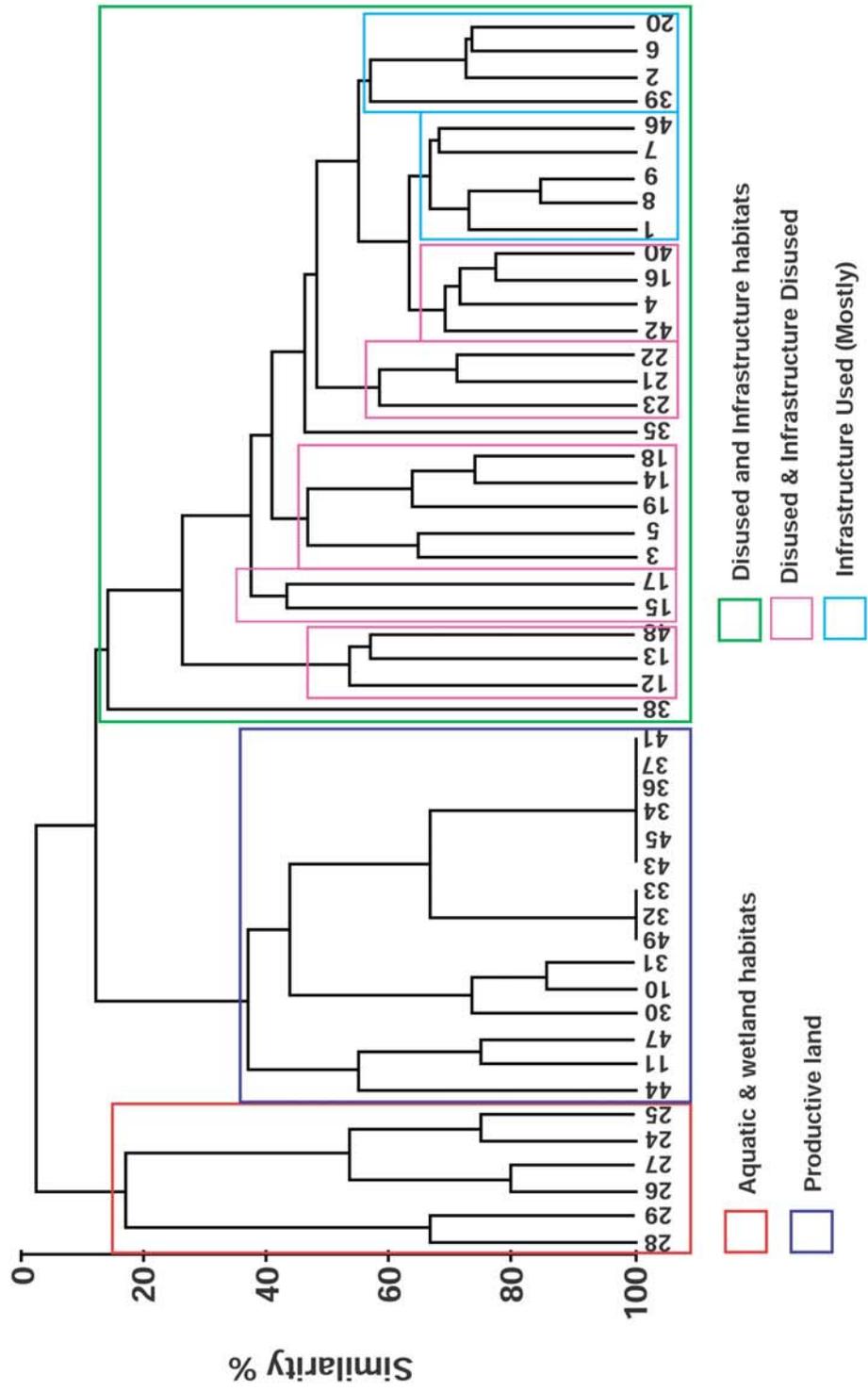
Figure 6: Bray Curtis dendrogram of site similarity based on molluscan composition

Aquatic & wetland habitats

Productive land

Disused and Infrastructure habitats

Disused & Infrastructure Disused

Infrastructure Used (Mostly)
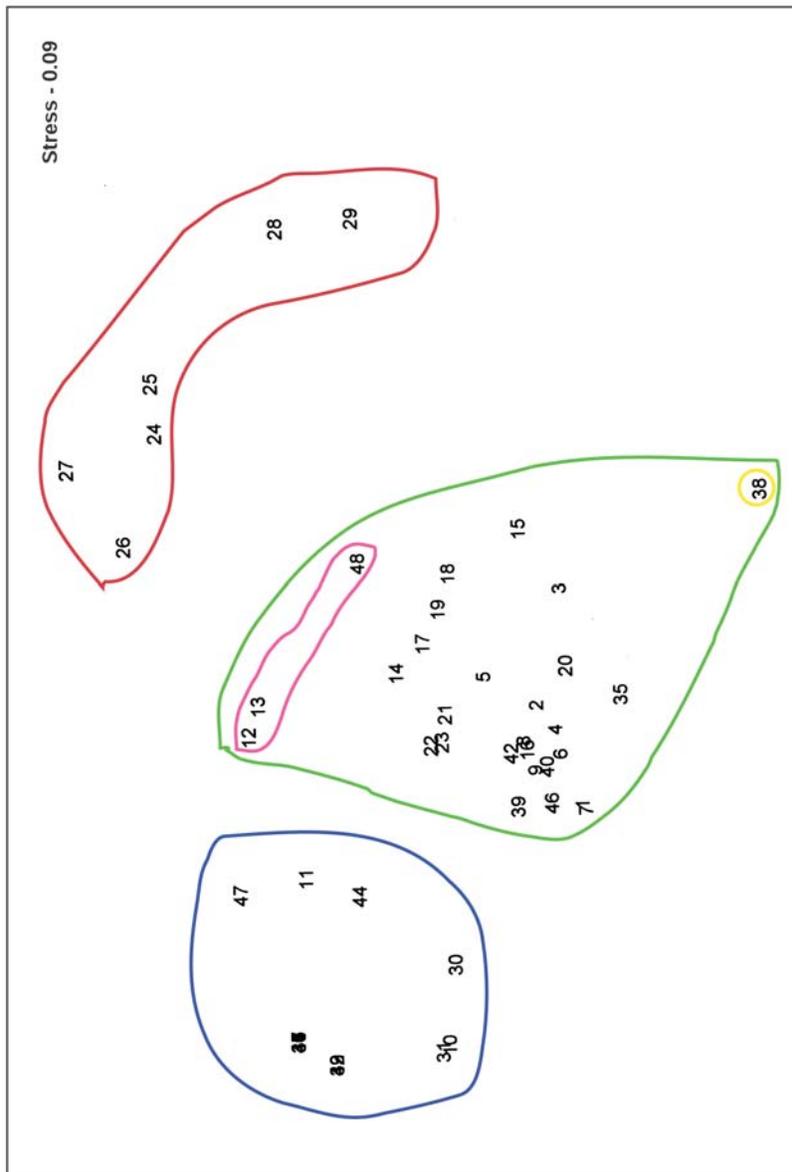
Figure 7: MDS ordination of site similarity based on molluscan composition

In summary, although the Disused, and Infrastructural (Disused and Used) areas are diverse in nature, and both groups have sites that contain high and low molluscan species diversity, when the molluscan species assemblages are compared using these multi-

dimensional statistical tools, the assemblages from these two categories can be statistically distinguished. Clearly, both are contributing to the molluscan diversity in the farm.

6.4 Potential for biodiversity loss from management changes

A number of potential extirpations of species are predicted to occur if certain changes are made in the management of the farm, both for vertebrates and butterflies (Good, 2001), and for Sciomyzidae and Syrphidae (Speight, 2001). The contribution of the semi-natural and infrastructural components to the farm molluscan fauna suggests that certain management changes would cause extirpations of molluscan species also. The potential management changes theoretically considered are: transformation of disused areas into spruce plantation, removal of old buildings, removal of a significant portion of walls and hedges to create larger productive areas, and the change from productive grassland into arable crop fields.

The expected species losses if these management changes were made are outlined in Appendix 5. The most significant loss of species diversity predicted would be due to drainage of Disused areas and subsequent planting with spruce trees. This would lead to a loss of 12 species, 13 if the new artificial wetland ponds were included for removal. The only species likely to survive in a monoculture conifer plantation would be *Columella aspera, Arion intermedius, Euconulus fulvus* and *Nesovitrea hammonis*, and as these are already present on the farm it would be a poor exchange in molluscan biodiversity terms. Surprisingly, no species would be lost by removal of the old buildings, as in spite of their high rank in order of species diversity, none of the species is restricted to the old buildings. While the calcareous mortar in the walls contributes to the species richness there, it is not enough to attract truly calcareous molluscs through an otherwise acid expanse. Similarly, the removal of most walls and hedges would probably only extirpate one species, *Vitrea contracta*. It must be emphasised that all these predictions are based on the retention of the farmhouse garden, and the open barn with its synanthropic habitats. Loss of these areas would have a wider implication in combination with the above management changes. It could be argued that the species found in the open barn

had been brought there from the walls and hedges from which the logs were sourced, and that being the case, the long term success of another 12 or so species could be questioned.

Finally, if all the grassland fields in productive use were changed to arable crops, only one species would be lost, *Milax gagates*. However, if the pig bog field was also used for an arable crop, *Vertigo pygmaea* would also be lost. If the wet Disused areas were all drained and planted with arable crops, the 12 species that would be lost in the spruce planting scenario would also be lost, along with the further 4 species that could survive in a spruce plantation.

In summary, the species diversity of the farm reflects the habitat diversity, and the contribution of catholic and synanthropic species to the molluscan biodiversity is high, and would be depleted by an intensification and homogenisation of the farm.

6.5 Survey methodology – implications

 A total of 24 of the 49 sites were sampled by both methods of field searching and by the removal of litter. The comparison of the numbers of species found in the field versus those found in litter samples is summarised in Table 7. The number of species recorded in the litter samples ranged from two (site 15) to twelve at sites 5 and 21, with a mean of 6.5 species/sample. The number of individual specimens retrieved from the litter samples ranged from three (site 15) to 108 in site 6. The mean number of snails per sample was 24.4.

In assessing the value from each method of sampling, the time effort put into both methods should be considered. Disregarding the time taken to travel from site to site and other ancillary activities, a hand search in this study took 30 minutes. By comparison, the litter collection took about 5 minutes in the field, but the effort required to process the litter sample would be approximately another 30 minutes, consisting of various stages involving drying, teasing apart of vegetation from time to time, sieving, picking of snails

out of sieved residue and identification. In terms of time effort, therefore, the two methods are largely equal.

By comparing the results of the two methodologies, the percentages of species that would have been missed by choosing one method only are shown in Table 8. There was considerable variation between the methods. Between 0% and 64% of species per site would have been missed if only field searching was used. This increases to between 9% and 78% of species that would have been missed if only litter samples were taken.

As the overall effort per site is effectively doubled by using both sampling methods together, it would be useful to understand the circumstances where the second method either adds very little information, or adds important additional information, and, if one method should be chosen, which it should be.

In the sites where very little extra information was gained by the litter sample, for example Sites 7, 8, 9, 16 and 20, the habitat had a good supply of molluscan refugia such as logs and plastic, where snails and slugs congregate, and a low diversity of vegetated areas where snails and slugs can disperse. In contrast, the areas where the most species are missed by hand searching alone are the areas with the densest vegetation, and additionally those that are wet in nature. In these cases molluscs are dispersed, and often smaller in size, and are difficult to see in the vegetation, as wet litter clumps together and snails adhere to these wet surfaces.

It can be concluded, therefore, that extreme caution should be employed in field sampling, particularly in highly vegetated situations with damp habitat, particularly in wet conditions. In very few circumstances should one method alone be considered reliable in assessing the entire molluscan fauna. As field sampling was less reliable in wet areas, it could be surmised that, in general, field sampling should be considered to be less reliable during or shortly after heavy rain. A careful look at the species missed in the field across the range of sites also suggests that field sampling should not be considered to be

reliable as a sole method when very small species, or species occurring rarely at a site, are being investigated.

If the overall farm species list is considered, excluding the fully aquatic species that have to be collected by net, only two species were missed by field sampling , compared with the 21 species missed in the litter samples (the 16 slug species and 5 snails). The conclusion can therefore be made that methods employed should reflect the required information outputs. If a general inventory of a large site is required, as many field searches as possible should be undertaken over as wide a habitat range as possible, with additional litter samples from wetter habitats. However, if an understanding of the species assemblages from the different habitats is of most interest, then both field and litter sampling would be advisable.

Table 7: Comparison of numbers of species found in the field versus those found in litter samples

Site No.	Category	No. of species	No. of species in field	No. of species in sample	No. of species only in litter sample	No. of specimens in litter sample	Species found only in litter sample
7	IU	23	22	7	1	27	*Vitrina pellucida*
5	ID	20	18	12	2	54	*Potamopyrgus antipodarum, Leiostyla anglica*
1	IU	19	15	8	4	67	*Vitrina pellucida, Vitrea contracta, Balea perversa, Candidula intersecta*
9	IU	18	17	5	1	11	*Balea perversa*
19	D	18	16	11	2	39	*Carychium minimum, Lauria cylindracea*
21	D	18	15	12	2	45	*Oxychilus cellarius, Euconulus fulvus*
23	D	17	14	5	3	11	*Carychium minimum, Nesovitrea hammonis, Aegopinella pura*
40	IU	16	15	4	1	6	*Vitrina pellucida*
8	D	15	15	4	0	15	
16	IU	15	15	4	0	9	
2	ID	14	13	9	1	31	*Leiostyla anglica*
4	ID	14	12	7	2	34	*Aegopinella pura, Oxychilus cellarius*
14	ID	14	12	5	2	13	*Oxychilus cellarius, Pisidium personatum*
17	D	14	12	4	2	9	*Columella aspera, Pisidium personatum*
22	D	13					
42	D	13	10	5	3	11	*Aegopinella pura, Aegopinella nitidula, Oxychilus cellarius*
12	ID	12	9	6	3	13	*Columella aspera, Nesovitrea hammonis, Aegopinella pura*
18	D	12	11	4	1	13	*Aegopinella pura*
3	D	11	4	8	7	25	*Carychium minimum, Potamopyrgus antipodarum, Leiostyla anglica, Euconulus fulvus, Balea perversa, Cochlicopa lubrica, Ashfordia granulata*
6	ID	11	10	7	1	108	*Oxychilus cellarius*
48	IU	11	4	10	7	26	*Galba truncatula, Columella aspera, Vitrea crystallina, Nesovitrea hammonis, Euconulus fulvus, Clausilia personatum*
13	IU	10	5	9	5	19	*Cochlicopa lubrica, Columella aspera, Nesovitrea hammonis, Oxychilus cellarius, Euconulus fulvus*
15	D	9	8	2	1	3	*Pisidium personatum*
20	D	8	8	4	0	13	
35	D	7	5	4	2	8	*Oxychilus cellarius, Balea perversa*

Table 8: Number of species missed by different methods of sampling

Site No.	Category	No. of Species at site	No. of species in field	No. of species In litter sample	No. species missed by field searching	No. species missed by litter collection	% species missed by field searching	% species missed by litter collection
7	IU	23	22	7	1	16	4%	70%
5	ID	20	18	12	2	8	10%	40%
1	IU	19	15	8	4	11	21%	58%
9	IU	18	17	5	1	13	6%	72%
19	D	18	16	11	2	7	11%	39%
21	D	18	15	12	3	6	17%	33%
23	D	17	14	5	3	12	18%	71%
40	IU	16	15	4	1	12	25%	75%
8	D	15	15	4	0	11	0%	73%
16	IU	15	15	4	0	11	0%	73%
2	ID	14	13	9	1	5	7%	36%
4	ID	14	12	7	2	7	14%	50%
14	ID	14	12	5	2	9	14%	64%
17	D	14	12	4	2	10	14%	71%
42	D	13	10	5	3	8	23%	61%
12	D	12	9	6	3	6	25%	50%
18	ID	12	11	4	1	8	8%	67%
3	D	11	4	8	7	3	64%	27%
6	D	11	10	7	1	4	9%	36%
48	ID	11	4	10	7	1	64%	9%
13	IU	10	5	9	5	1	50%	10%
15	IU	9	8	2	1	7	11%	78%
20	D	8	8	4	0	4	0%	50%
35	D	7	5	4	2	3	29%	43%

6.6 Conservation interest of species

The richest places for molluscs are those on lime-rich soils and/or long-established habitats e.g. wetlands, old woodland, calcareous grassland, large, slow-flowing rivers, lakes and so on. These habitats also tend to support the species of highest conservation value. However, most of these habitats are absent on the farm – there is little freshwater, the wetlands are relatively acid and the woodlands are secondary and small in area, therefore the fauna is comprised mainly of catholic species with none of the most sensitive mollusc species present.

Given that the farm lies in a geologically acid area and that old, semi-natural habitat is not extensive, the fauna of 57 species is remarkably rich for such a small area. There are unlikely to be many similar sites in County Cork with such a diverse mollusc fauna. In spite of the absence of species that are rare in Ireland or throughout their range, the farm does support a small suite of species that in an Irish context may be considered as notable. For example, *Balea perversa* lives mostly on the bark of trees where it grazes upon lichens, and is especially sensitive to atmospheric pollution. This species was found in several sites on the farm, particularly on hawthorn and apple. *Leiostyla anglica* is found in damp, shaded habitats and wetlands and may be considered a species indicative of a better than average quality site. However, other species which occur in Cork (see Appendix 6) and which are regarded as good indicators such as *Acicula fusca* and *Zenobiella subrufescens* are absent.

Three terrestrial species are conspicuous by their absence on the farm: *Carychium tridentatum, Acanthinula aculeata* and *Trichia hispida*. All three are inhabitants of a range of generally damp, shaded habitats. Whilst the first two species have a scattered distribution in Cork, *T. hispida* is widespread and the most catholic of the three. There are no clear reasons for its apparent absence.

Two species observed in 2000, the aquatic gastropod *Gyraulus albus* recorded in the farm pond*,* and the wetland snail *Vertigo antivertigo* in a wet flush in Snipe Bog, were not found during the present study. *G. albus* is unlikely to have been missed and may well have disappeared from the farm. The habitat in Snipe Bog is typical of that required by *V. antivertigo*, therefore it is presumed to be rather local in distribution and to have beenoverlooked during this survey. Given that considerable effort was made to relocate this species, it must be rare at this site if it is still present.

One species was recorded new to County Cork, the bladder snail *Physella acuta*. It was the most abundant aquatic snail in the newly created wetland areas and pond (sites 24-27). This is a North American species which has spread throughout much of Europe in both wild and artificial locations. At present it is known only from a few locations in

Ireland (Grand Canal west of Dublin and Lough Swilly, East Donegal). It is probable that *P. acuta* was inadvertently introduced to the farm on plants imported from aquarist suppliers. However, the species may be taking advantage of a new habitat and may not survive once the wetland habitats become more established over the following few years.

Overall, the species richness of Mollusca at Glinny-Boulaling Farm was high, and supports the view that a farm can be considered an important biogeographical unit. Although it is a fact that the species list for the farm, although numerous, is made up of commonly distributed species, the corollary of this thesis is that the species that are present are common in Ireland because farm units such as this study farm play an important role in providing the habitats to maintain them.

7. Acknowledgements

8. References

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Appendix 1: Site Descriptions

Site No: 1	**Location Name**:	
Photograph: 	**Habitat Description**: Sandstone barn, mortared, no roof. Ferns and lichens on the walls. Rubble with nettles and cleavers at base of outside walls. Inside with lots of old planks, sacks, and rubble. Loose mossy substrate.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 2	**Location Name**:	
Photograph: 	**Habitat Description**: Sandstone wall, SW facing, with moss, ferns, ivy, and brambles. Occasional overhanging hawthorn.	
	Classification:	Infrastructure Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 3	**Location Name**:	
Photograph: 	**Habitat Description**: Outfall from well and ponds over sandstone wall. Mossy splash zone.	
	Classification:	Infrastructure Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 4	**Location Name**:	
Photograph: 	**Habitat Description**: Old orchard. Very old gnarled apple trees with an under-storey of *Petasites*, cleavers, nettles, celandine	
	Classification:	Infrastructure Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 5	Location Name:
Photograph:	**Habitat Description**: Well and seepage above pond and pond margin. Weeds and rubbish. Flora includes *Ranunculus repens, Holcus*, celandine, nettles and brambles.

Classification:	Infrastructure Disused
Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 6	Location Name:
Photograph:	**Habitat Description**: Mudstone and brick wall facing west. Covered with ivy and with an under-storey of nettles, brambles, cleavers and dock.

Classification:	Infrastructure Used
Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 7	Location Name:
Photograph:	**Habitat Description**: Barn to east of Glinny House. Roofed barn with grassland and scrub outside. Large piles of logs, Sheets of cardboard and fertilizer sacks.

Classification:	Infrastructure Used
Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 8	Location Name: Priestgate Field
Photograph:	**Habitat Description**: Bank along west margin of Priestgate Field. Dry wall and bank overgrown with gorse, bramble and *Hypericum*. Some hawthorn trees and one large sycamore. A few loose stones.

Classification:	Infrastructure Used
Mollusc sampling:	a) 30 Minute field search b) Litter sample

Appendix 1 continued:

Site No: 9	Location Name: East Field
Photograph:	**Habitat Description**: Bank along northern margin of East Field. Sandstone wall with bank on top. Some ivy, gorse, bramble, ground elder, sycamore, bracken etc. Large heap of old pallets and logs near western end.

| | Classification: | Infrastructure Used |
| | Mollusc sampling: | a) 30 Minute field search
b) Litter sample |

Site No: 10	Location Name: Huntingate Field
Photograph:	**Habitat Description**: Intensive barley field. Barley with no under-storey and no associated weeds. Substrate of mud with algal film. Molluscicide pellets and dead slugs.

| | Classification: | Productive |
| | Mollusc sampling: | a) 30 Minute field search |

Site No: 11	Location Name: Huntingate Field
Photograph:	**Habitat Description**: Set-aside at north-east edge, base of slope of the barley field. Bare, muddy ground, rutted with tracks. Tussocks of *Holcus* and other grasses, *Juncus, Carex nigra, Ranunculus, Bellis, Taraxacum* and a few small shrubs.

| | Classification: | Productive |
| | Mollusc sampling: | a) 30 Minute field search
b) Litter sample |

Site No: 12	Location Name: Snipe Bog
Photograph:	**Habitat Description**: Rough grassland with *Deschampsia, Holcus, Agrostis, Juncus* and some gorse scrub. Saturated ground in places with occasional runnels with standing water.

| | Classification: | Disused |
| | Mollusc sampling: | a) 30 Minute field search
b) Litter sample |

Site No: 13	Location Name: Snipe Bog	
Photograph: 	**Habitat Description**: Thick willow scrub and bramble. Runnels of standing water.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 14	Location Name: Hill Bog	
Photograph: 	**Habitat Description**: Wet grassland with *Deschampsia, Filipendula*, occasional *Cardamine*. Willow scrub along northern margins.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 15	Location Name: Snipe Bog/Long Bog	
Photograph: 	**Habitat Description**: Boundary between Snipe Bog and Long Bog. 2-3m wide woodland strip and bank with wet ditch at the base. Mostly beech and holly trees with under-storey of litter and moss. Ferns along edge of the bank and ditch.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 16	Location Name: Bulls Field/East Field	
Photograph: 	**Habitat Description**: Old lane flanked by banks with growth of scrub, herbs and trees. Much of the hedge has been recently cut. Lots of fallen logs, moss and leaf litter.	
	Classification:	Infrastructure Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Appendix 1 continued:

Site No: 17	Location Name: Alder Wood
Photograph: 	**Habitat Description**: North-eastern end of Alder Wood. Relatively dry woodland and scrub with beech, sycamore and lime. Ground with leaf litter, fallen branches and some mossy patches.

	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 18	Location Name: Small Bog
Photograph: 	**Habitat Description**: Sloping wetland with *Deschampsia, Filipendula*, gorse, *Salix* scrub. Saturated ground on lower slopes with small pools of standing water.

	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 19	Location Name: Alder Wood
Photograph: 	**Habitat Description**: North-western part of alder wood. Alder carr with springs, running streams, and pools. Mostly *Iris*, moss, and *Ranunculus* under-storey.

	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 20	Location Name: Lawn
Photograph: 	**Habitat Description**: Bank along western margin of Lawn. Stone bank overgrown with ferns and ivy, with mature sycamore, and beech. Under-storey of nettles and bramble, few logs.

	Classification:	Infrastructure Used
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Appendix 1 continued:

Site No: 21	Location Name: Pig Bog	
Photograph:	**Habitat Description**: South end of Pig Bog. Mostly *Holcus* and *Festuca* grassland with patches of *Iris*.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 22	Location Name: Pig Bog	
Photograph:	**Habitat Description**: Middle section of Pig Bog. Mostly *Holcus* dominated grassland with *Juncus*.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search

Site No: 23	Location Name: Pig Bog	
Photograph:	**Habitat Description**: North end of Pig Bog. Mostly *Holcus* dominated grassland with *Juncus, Rumex, Urtica.* Logs, old pallets and polythene sheets in the site.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 24	Location Name: Long Bog	
Photograph:	**Habitat Description**: Pond in Long Bog. Created pond with some algal scum. *Typha* and *Juncus* at the margins.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) Aquatic sample sorted in laboratory

Appendix 1 continued:

Site No: 25	Location Name: Long Bog	
Photograph:	**Habitat Description**: Small stream running down eastern edge of Pairc Giol and entering newly created pond. Little flow with dense *Mentha, Glyceria fluitans,* and *Lemna*.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) Aquatic sample sorted in laboratory

Site No: 26	Location Name: Pairc Giol	
Photograph:	**Habitat Description**: North end of a series of artificial wetland cells. Pools of standing water with grasses, *Juncus, Carex nigra*.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) Aquatic sample sorted in laboratory

Site No: 27	Location Name: Pairc Giol	
Photograph:	**Habitat Description**: South end of a series of artificial wetland cells. Pools of standing water with grasses, *Juncus, Carex nigra, Glyceria* etc.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) Aquatic sample sorted in laboratory

Site No: 28	Location Name: Farm pond	
Photograph:	**Habitat Description**: Western of the 2 farm ponds. Highly enriched pond with no emergent plants. Algal bloom present when sampled in May. Muddy substrate.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) Aquatic sample sorted in laboratory

Appendix 1 continued:

Site No: 29	Location Name: Farm pond	
Photograph: 	**Habitat Description:** Eastern of the 2 farm ponds. Highly enriched pond with no emergent plants. Surface algal scum. Muddy substrate with dead leaves and detritus.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) Aquatic sample sorted in laboratory

Site No: 30	Location Name: East Field	
Photograph: No photo taken	**Habitat Description:** Unimproved pasture with grasses and herbs. Grasses included *Poa, Lolium, Dactylus, Agrostis, Holcus.* Herbs included *Prunella, Urtica, Cirsium, Ranunculus, Bellis, Lotus, Trifolium* etc.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 31	Location Name: Long Field	
Photograph: 	**Habitat Description:** Unfertilized pasture. Mostly white clover.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 32	Location Name: Pairc Giol	
Photograph: No photo taken	**Habitat Description:** North-west part of field. Unfertilized pasture. Grassland.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Appendix 1 continued:

Site No: 33	Location Name: Bulls Field	
Photograph: 	**Habitat Description**: Unfertilized pasture. Grassland.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 34	Location Name: Priestgate Field	
Photograph: 	**Habitat Description**: Unfertilized pasture. Grassland.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 35	Location Name: Priestgate Field	
Photograph: No photo taken	**Habitat Description**: Border of Priestgate Field. Bramble scrub in front of dry stone wall.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 36	Location Name: Priestgate Field	
Photograph: No photo taken	**Habitat Description**: 3m wide strip of grassland and *Potentilla anserina* lying between the pasture and the hedgebank.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 37	Location Name: Brake	
Photograph: No photo taken	**Habitat Description**: Fertilized spring pasture. Mixed grassland.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 38	Location Name: Brake	
Photograph: No photo taken	**Habitat Description**: Northern corner of filed. Mostly bramble and bracken.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) 30 Minute field search

Site No: 39	Location Name: Dogs Field	
Photograph: 	**Habitat Description**: Rough grassland with *Urtica* and *Rumex*. Many logs, planks, old carpets, plastic containers.	
	Classification:	Infrastructure Used
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 40	Location Name: Dogs Field	
Photograph: 	**Habitat Description**: Elm thicket. Elm trees with a very sparse under-storey of grasses and herbs. Fallen timber and stones. Trampled by cattle.	
	Classification:	Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 41	Location Name: Glinny Field	
Photograph:	**Habitat Description**: Fertilized spring pasture. Heavily grazed grassland.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 42	Location Name: Orchard Field	
Photograph: No photo taken	**Habitat Description**: Margin of Orchard Field. Old bank with hawthorn and scrub. Some loose rocks and fallen timber.	
	Classification:	Infrastructure Disused
	Mollusc sampling:	a) 30 Minute field search b) Litter sample

Site No: 43	Location Name: Orchard Field	
Photograph:	**Habitat Description**: 'Rumex' pasture. Mostly grassland.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 44	Location Name: Lodge Field	
Photograph: No photo taken	**Habitat Description**: Old hay field with some matting. Mostly grasses and *Juncus*. Very sparse litter – generally bare soil.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Site No: 45	Location Name: Lawn
Photograph:	**Habitat Description**: Fertilized pasture. Grassland, mostly *Lolium*.

| | **Classification:** | Productive |
| | **Mollusc sampling:** | a) 30 Minute field search |

Site No: 46	Location Name: Glinny Farmhouse
Photograph: No photo taken	**Habitat Description**: House garden Walls, slabs, pot plants, troughs, leaf litter.

| | **Classification:** | Infrastructure Used |
| | **Mollusc sampling:** | a) 30 Minute field search |

Site No: 47	Location Name: Pairc Giol
Photograph:	**Habitat Description**: Unfertilized pasture. Mixed grassland adjacent to artificial wetland cells.

| | **Classification:** | Productive |
| | **Mollusc sampling:** | a) 30 Minute field search |

Site No: 48	Location Name: Long Bog
Photograph:	**Habitat Description**: Wet, rank grassland with *Molinia, Filipendula*, with some bramble, carices and grasses.

| | **Classification:** | Disused |
| | **Mollusc sampling:** | a) 30 Minute field search
b) Litter sample |

Appendix 1 continued:

Site No: 49	Location Name: Middle Field	
Photograph:	**Habitat Description**: Fertilized spring pasture. Mixed grassland with occasional *Rumex* and *Urtica*.	
	Classification:	Productive
	Mollusc sampling:	a) 30 Minute field search

Appendix 2: Results of Molluscan sampling (F = field, S = Sample)

	1 F	1 S	2 F	2 S	3 F	3 S	4 F	4 S	5 F	5 S	6 F	6 S	7 F	7 S	8 F	8 S	9 F	9 S	10 F	10 S
Potamopyrgus antipodarum						1				4										
Carychium minimum						1			X	4										
Carychium tridentatum																				
Physella acuta																				
Galba truncatula									X											
Stagnicola fuscus									X											
Radix balthica																				
Anisus spirorbis																				
Hippeutis complanatus																				
Oxyloma pfeifferi																				
Cochlicopa lubrica	X	12	X	2		3	X	3	X	12	X	1			X					
Cochlicopa lubricella													X	8						
Columella aspera																				
Vertigo pygmaea																				
Lauria cylindracea	X	41	X	10	X	1	X	5	X	4	X	22			X	12	X	4		
Leiostyla anglica				3		1				1										
Punctum pygmaeum							X													
Discus rotundatus	X		X		X		X	5	X	5			X	1	X	1	X			
Arion ater/rufus	X												X		X		X			
Arion flagellus	X												X		X		X			
Arion subfuscus													X				X			
Arion circumscriptus							X						X							
Arion silvaticus													X							
Arion distinctus	X												X		X		X		X	
Arion intermedius									X											
Vitrina pellucida		3												1			X	1		
Vitrea crystallina																				
Vitrea contracta		1																		
Nesovitrea hammonis									X	2										
Aegopinella pura			X	1				10	X	1	X	1	X		X		X			
Aegopinella nitidula	X						X		X		X		X		X		X			
Oxychilus draparnaudi	X	2							X				X							
Oxychilus cellarius			X	2				1	X	2		1			X	1	X			
Oxychilus alliarius			X												X		X	2		
Zonitoides excavatus																				
Zonitoides nitidus																				
Milax gagates																				
Tandonia budapestensis	X												X				X		X	
Boettgerilla pallens													X							
Limax maculatus			X										X							
Limax flavus																				
Lehmannia marginata			X										X							
Deroceras leave																				
Deroceras reticulatum	X		X				X		X		X		X		X		X		X	
Deroceras panormitanum	X				X		X		X				X				X			
Euconulus fulvus						1														
Clausilia bidentata	X		X	2	X		X	6	X	1	X	22	X	1	X		X	3		
Balea perversa		2				1	X	4	X				X	1	X			1		
Candidula intersecta		1																		
Ashfordia granulata			X	5		16	X		X	17	X	47	X	15						
Trichia striolata	X	5	X	5			X		X	1	X	14	X		X	1	X			
Cepaea nemoralis	X		X	1							X		X		X		X			
Helix aspersa	X								X											
Pisidium casertanum																				
Pisidium personatum																				
Pisidium obtusale																				
Pisidium milium																				
Pisidium subtruncatum																				
No. of specimens in Sample		67		31		25		34		54		108		27		15		11		

Appendix 2 (continued):

	11 F	11 S	12 F	12 S	13 F	13 S	14 F	14 S	15 F	15 S	16 F	16 S	17 F	17 S	18 F	18 S	19 F	19 S	20 F	20 S
Potamopyrgus antipodarum																				
Carychium minimum			X				X											1		
Carychium tridentatum																				
Physella acuta																				
Galba truncatula	X	11	X	7	X	4	X	4							X	4	X	2		
Stagnicola fuscus																				
Radix balthica																	X			
Anisus spirorbis			X		X	4														
Hippeutis complanatus																				
Oxyloma pfeifferi															X		X			
Cochlicopa lubrica						1					X	2			X		X	4	X	
Cochlicopa lubricella																				
Columella aspera				1		1								2						
Vertigo pygmaea																				
Lauria cylindracea											X	1						1	X	
Leiostyla anglica							X	3							X	3	X	9		
Punctum pygmaeum																				
Discus rotundatus							X		X		X		X		X		X	3	X	
Arion ater/rufus	X		X				X						X							
Arion flagellus																	X			
Arion subfuscus	X		X								X						X			
Arion circumscriptus											X									
Arion silvaticus																				
Arion distinctus	X										X		X							
Arion intermedius							X						X		X		X			
Vitrina pellucida																				
Vitrea crystallina			X	1																
Vitrea contracta																				
Nesovitrea hammonis				2		4														
Aegopinella pura				1					X		X		X			1			X	1
Aegopinella nitidula											X		X				X	2		
Oxychilus draparnaudi																				
Oxychilus cellarius						1		2			X	4	X	1	X		X	1	X	5
Oxychilus alliarius									X											
Zonitoides excavatus					X	2							X				X	1		
Zonitoides nitidus			X										X				X			
Milax gagates																				
Tandonia budapestensis																				
Boettgerilla pallens																				
Limax maculatus											X		X							
Limax flavus																				
Lehmannia marginata									X		X		X							
Deroceras leave							X		X						X		X			
Deroceras reticulatum	X		X		X		X				X									
Deroceras panormitanum							X				X									
Euconulus fulvus						1														
Clausilia bidentata							X		X		X		X	5	X		X	4	X	6
Balea perversa									X	1										
Candidula intersecta																				
Ashfordia granulata																				
Trichia striolata											X	2							X	1
Cepaea nemoralis							X		X						X				X	
Helix aspersa																				
Pisidium casertanum																				
Pisidium personatum			X	1	X	2	X	2		2				2	X	5	X	11		
Pisidium obtusale								2												
Pisidium milium																				
Pisidium subtruncatum																				
No. of specimens in Sample		11		13		19		13		3		9		9		13		39		13

	21 F	21 S	22 F	22 S	23 F	23 S	24 S	25 S	26 S	27 S	28 S	29 S	30 F	30 S	31 F	31 S	32 F	32 S	33 F	33 S
Potamopyrgus antipodarum							X	X			X	X								
Carychium minimum						1														
Carychium tridentatum																				
Physella acuta							X	X	X	X										
Galba truncatula							X		X											
Stagnicola fuscus																				
Radix balthica																				
Anisus spirorbis																				
Hippeutis complanatus											X	X								
Oxyloma pfeifferi																				
Cochlicopa lubrica	X	9	X		X	4							X							
Cochlicopa lubricella	X		X																	
Columella aspera																				
Vertigo pygmaea	X	3																		
Lauria cylindracea	X	10	X																	
Leiostyla anglica																				
Punctum pygmaeum	X																			
Discus rotundatus	X	1	X		X															
Arion ater/rufus	X		X		X								X							
Arion flagellus			X		X															
Arion subfuscus	X		X		X															
Arion circumscriptus																				
Arion silvaticus					X															
Arion distinctus					X								X		X					
Arion intermedius																				
Vitrina pellucida																				
Vitrea crystallina	X	2																		
Vitrea contracta																				
Nesovitrea hammonis		3				5														
Aegopinella pura	X	3				1														
Aegopinella nitidula																				
Oxychilus draparnaudi																				
Oxychilus cellarius		1	X																	
Oxychilus alliarius					X															
Zonitoides excavatus	X	1	X		X															
Zonitoides nitidus			X		X															
Milax gagates													X		X		X		X	
Tandonia budapestensis													X		X					
Boettgerilla pallens																				
Limax maculatus																				
Limax flavus																				
Lehmannia marginata																				
Deroceras leave	X																			
Deroceras reticulatum	X		X		X								X		X		X		X	
Deroceras panormitanum																				
Euconulus fulvus		3	X																	
Clausilia bidentata	X	8	X		X	1														
Balea perversa																				
Candidula intersecta					X															
Ashfordia granulata																				
Trichia striolata	X	1			X															
Cepaea nemoralis																				
Helix aspersa																				
Pisidium casertanum							X	X			X									
Pisidium personatum								X	X	X										
Pisidium obtusale												X								
Pisidium milium											X	X								
Pisidium subtruncatum											X									
No. of specimens in Sample		45				11														

Appendix 2 (continued):

	35		36		37		38		39		40		41		42	
	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S
Potamopyrgus antipodarum																
Carychium minimum																
Carychium tridentatum																
Physella acuta																
Galba truncatula																
Stagnicola fuscus																
Radix balthica																
Anisus spirorbis																
Hippeutis complanatus																
Oxyloma pfeifferi																
Cochlicopa lubrica									X		X	1				
Cochlicopa lubricella																
Columella aspera																
Vertigo pygmaea																
Lauria cylindracea	X										X				X	
Leiostyla anglica																
Punctum pygmaeum																
Discus rotundatus	X	4							X		X	1			X	4
Arion ater/rufus											X				X	
Arion flagellus																
Arion subfuscus	X								X						X	
Arion circumscriptus																
Arion silvaticus											X					
Arion distinctus	X								X							
Arion intermedius																
Vitrina pellucida												1				
Vitrea crystallina																
Vitrea contracta																
Nesovitrea hammonis																
Aegopinella pura																1
Aegopinella nitidula											X					4
Oxychilus draparnaudi									X							
Oxychilus cellarius		2							X		X					1
Oxychilus alliarius							X									
Zonitoides excavatus																
Zonitoides nitidus																
Milax gagates																
Tandonia budapestensis									X							
Boettgerilla pallens															X	
Limax maculatus									X		X				X	
Limax flavus																
Lehmannia marginata											X					
Deroceras leave																
Deroceras reticulatum			X		X				X		X		X		X	
Deroceras panormitanum											X					
Euconulus fulvus																
Clausilia bidentata	X	1					X		X		X	3			X	
Balea perversa		1									X				X	1
Candidula intersecta																
Ashfordia granulata									X							
Trichia striolata									X		X				X	
Cepaea nemoralis																
Helix aspersa																
Pisidium casertanum																
Pisidium personatum																
Pisidium obtusale																
Pisidium milium																
Pisidium subtruncatum																
No. of specimens in Sample		8										6				11

Appendix 2 (continued):

	43		44		45		46		47		48		49	
	F	S	F	S	F	S	F	S	F	S	F	S	F	S
Potamopyrgus antipodarum														
Carychium minimum											X	12		
Carychium tridentatum														
Physella acuta														
Galba truncatula									X			5		
Stagnicola fuscus														
Radix balthica														
Anisus spirorbis														
Hippeutis complanatus														
Oxyloma pfeifferi														
Cochlicopa lubrica														
Cochlicopa lubricella			X											
Columella aspera												1		
Vertigo pygmaea														
Lauria cylindracea							X							
Leiostyla anglica														
Punctum pygmaeum														
Discus rotundatus							X				X	1		
Arion ater/rufus			X				X		X					
Arion flagellus							X							
Arion subfuscus			X				X							
Arion circumscriptus							X							
Arion silvaticus														
Arion distinctus							X							
Arion intermedius														
Vitrina pellucida														
Vitrea crystallina												1		
Vitrea contracta														
Nesovitrea hammonis												1		
Aegopinella pura														
Aegopinella nitidula							X							
Oxychilus draparnaudi							X							
Oxychilus cellarius							X				X	1		
Oxychilus alliarius														
Zonitoides excavatus														
Zonitoides nitidus														
Milax gagates													X	
Tandonia budapestensis							X							
Boettgerilla pallens														
Limax maculatus														
Limax flavus														
Lehmannia marginata														
Deroceras leave											X			
Deroceras reticulatum	X		X		X		X		X				X	
Deroceras panormitanum							X							
Euconulus fulvus												2		
Clausilia bidentata							X					1		
Balea perversa														
Candidula intersecta														
Ashfordia granulata							X							
Trichia striolata			X				X							
Cepaea nemoralis														
Helix aspersa							X							
Pisidium casertanum														
Pisidium personatum												1		
Pisidium obtusale														
Pisidium milium														
Pisidium subtruncatum														
No. of specimens in Sample												26		

Appendix 3: Molluscan faunas of other sites in County Cork

3.1 Fauna of a garden in Victoria Terrace, Glenbrook, Cork (W772678)

Cochlicopa lubrica	*Tandonia sowerbyi*
Lauria cylindracea	*Boettgerilla pallens*
Arion ater/rufus	*Limax maculatus*
Arion subfuscus	*Lehmannia valentiana*
Arion distinctus	*Deroceras reticulatum*
Aegopinella pura	*Deroceras panormitanum*
Aegopinella nitidula	*Trichia striolata*
Oxychilus draparnaudi	*Ashfordia granulata*
Tandonia budapestensis	*Helix aspersa*

3.2 Fauna of Ballyannan Wood, Cork (W879721)

Carychium minimum	*Aegopinella nitidula*
Carychium tridentatum	*Oxychilus cellarius*
Cochlicopa lubrica	*Oxychilus alliarius*
Cochlicopa lubricella	*Zonitoides excavatus*
Columella aspera	*Tandonia budapestensis*
Columella edentula	*Limax maximus*
Lauria cylindracea	*Lehmannia marginata*
Leiostyla anglica	*Deroceras reticulatum*
Discus rotundatus	*Euconulus fulvus*
Arion ater/rufus	*Clausilia bidentata*
Arion subfuscus	*Balea perversa*
Arion distinctus	*Trichia striolata*
Arion intermedius	*Trichia hispida*
Vitrea crystalline	*Zenobiella subrufescens*
Vitrea contracta	*Cepaea nemoralis*
Nesovitrea hammonis	*Cepaea hortensis*
Aegopinella pura	*Pisidium milium*

Appendix 4. Graphs of trait comparisons between species known from County Cork found on the farm with those not found on the farm, for traits and species listed on the molluscan database (Falkner *et al.*, 2001).

**Shell size of Cork Mollusca on farm and not on farm**
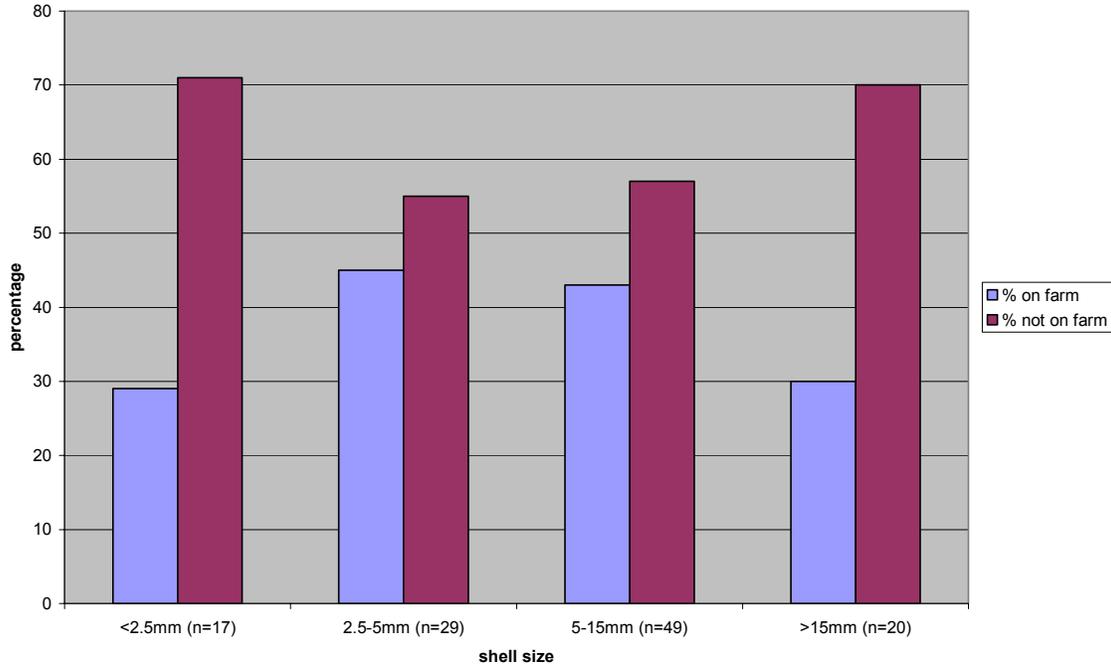
Figure 2 Shell shape comparisons of Cork mollusca on farm and not on farm
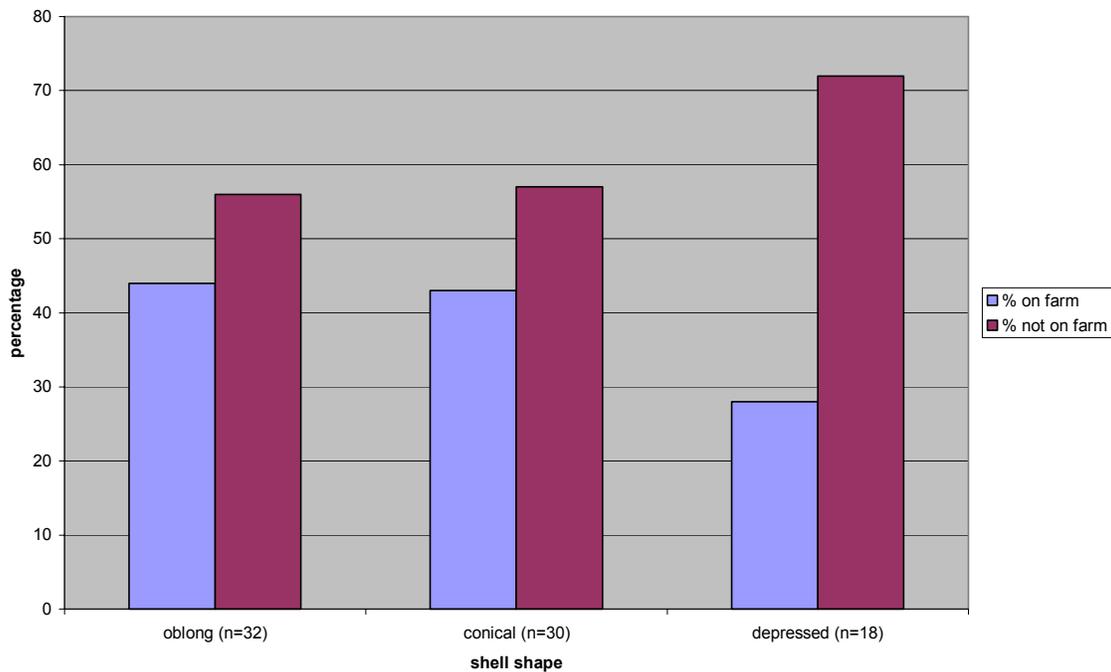
Shell thickness of Cork snails on farm and not on farm
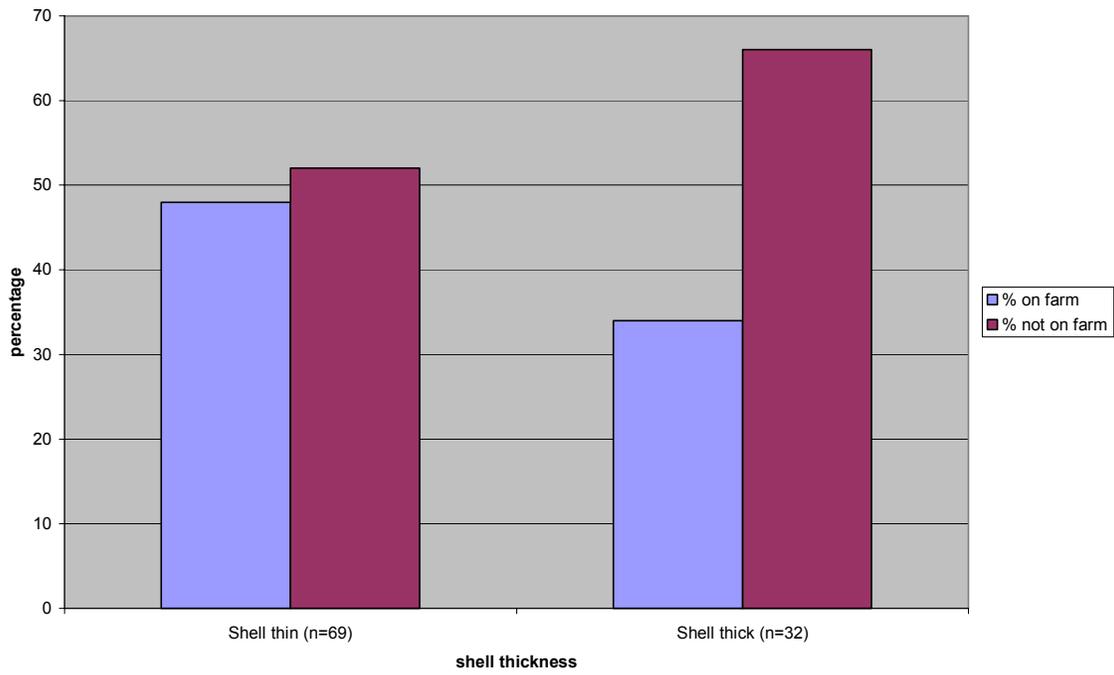
**Number of whorls in Cork species on farm and not on farm**
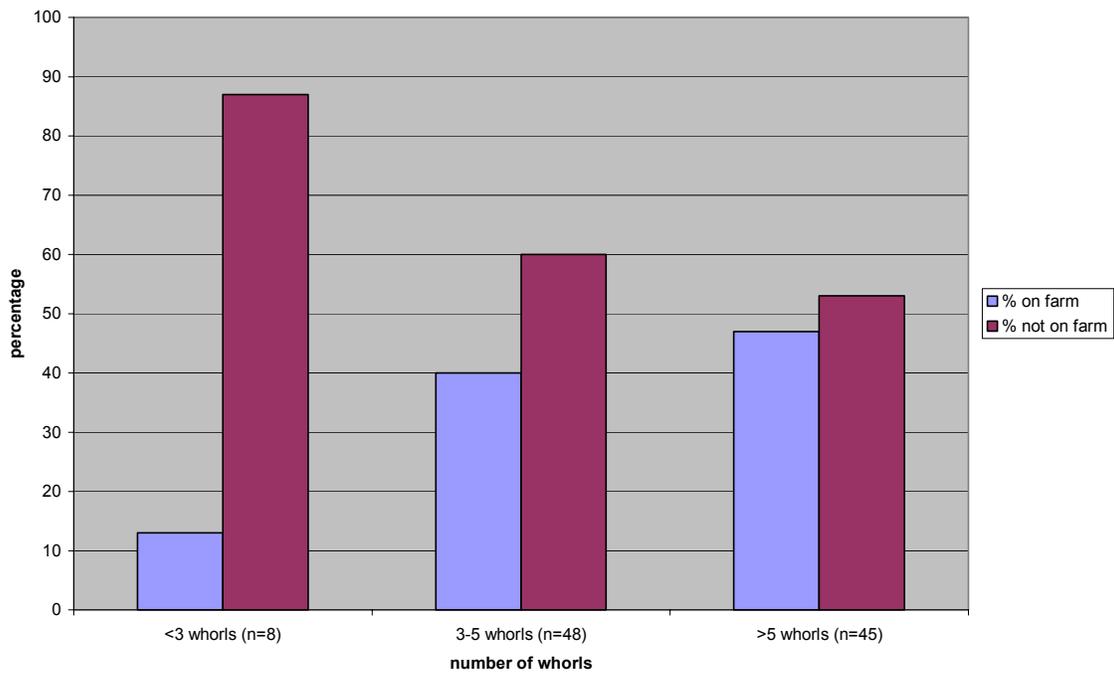
Reproductive strategy of Cork species on farm and not on farm
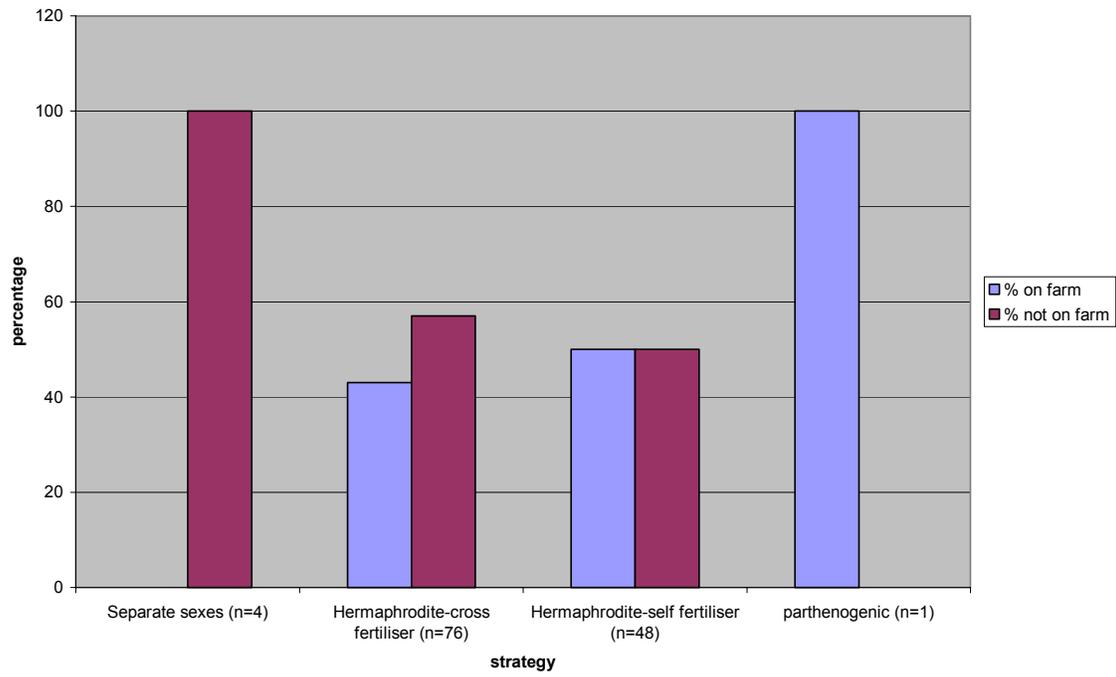
**Birth strategy of Cork species on farm and not on farm**
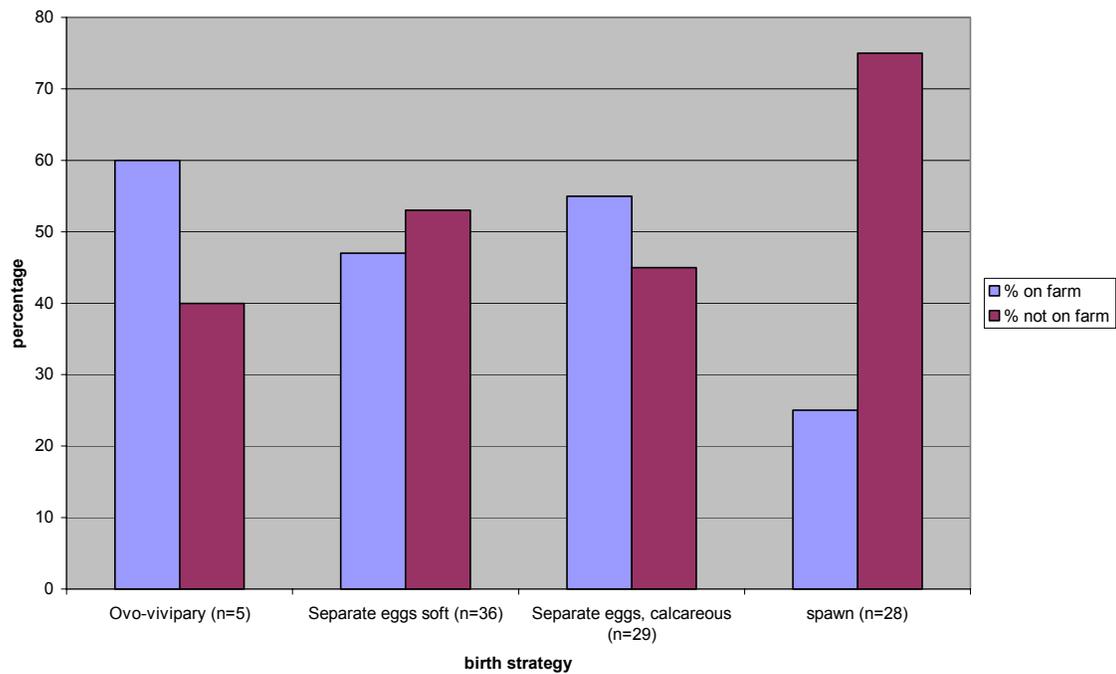
**Survival in dry conditions of Cork species on farm and not on farm**
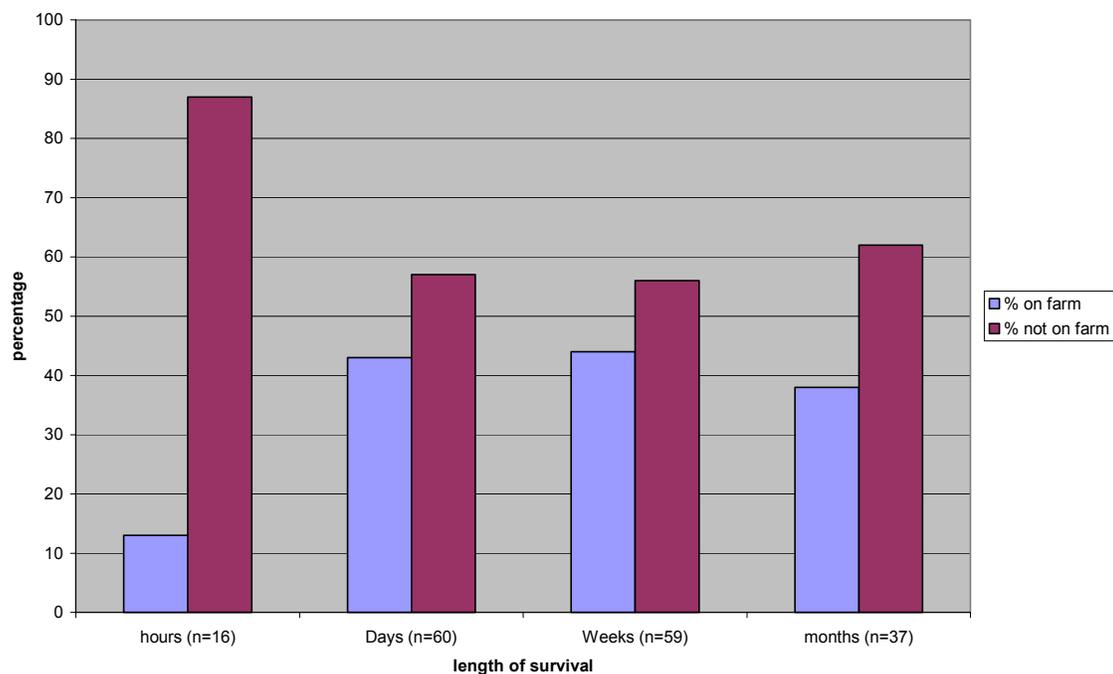
Food sources of Cork species on farm and not on farm
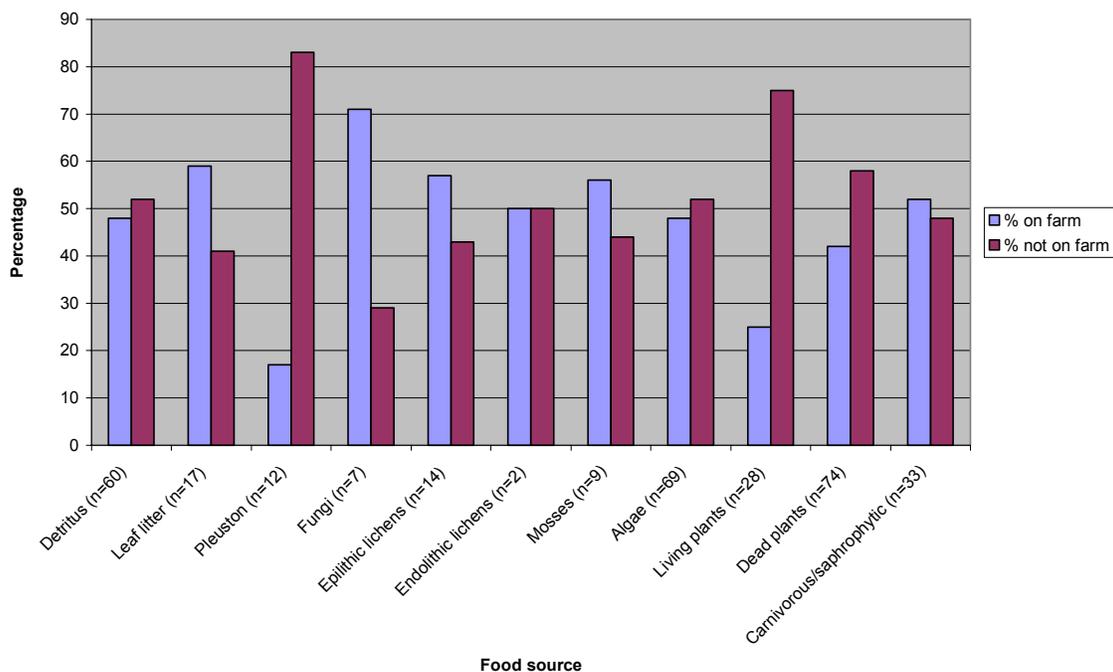
Shade preference of Cork species on farm and not on farm
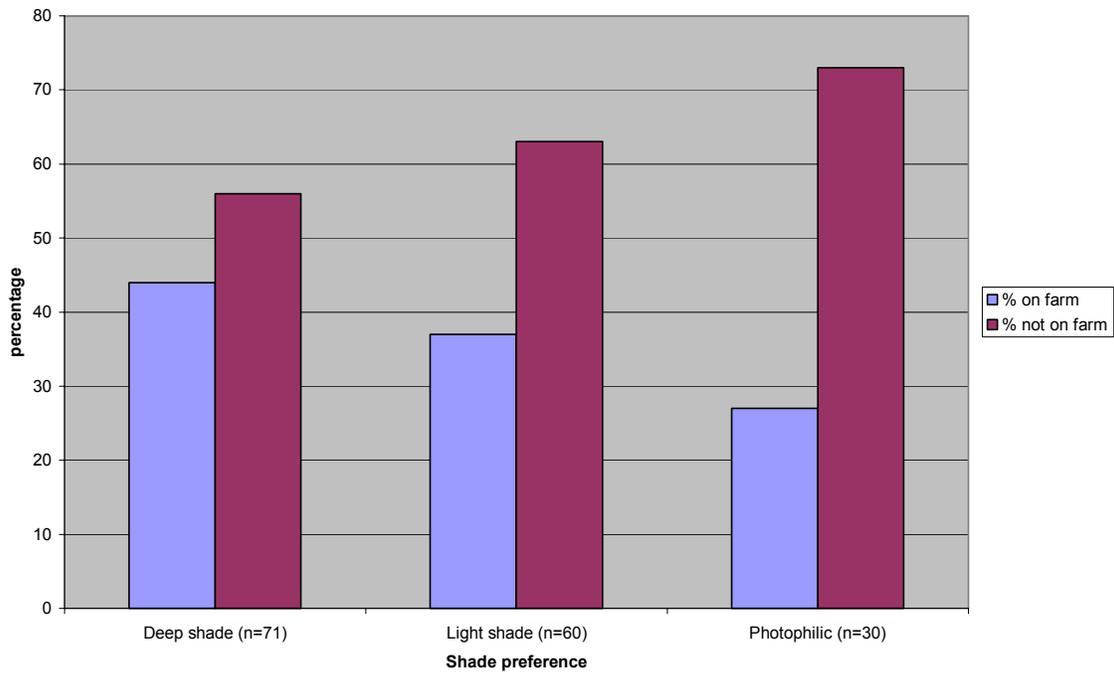
Wetness preferences of Cork species on farm and not on farm
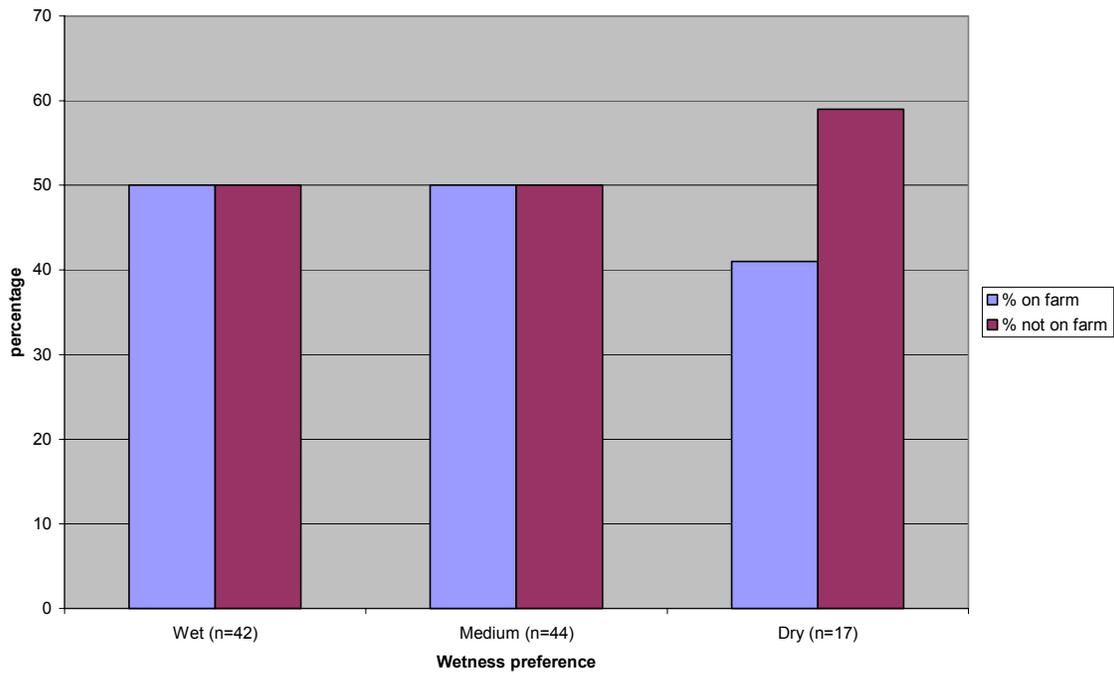
Appendix 5. Species predicted to be lost by theoretical changes in farm management practices.

Management change	Species predicted to be lost	Species predicted to be gained
Change from disused areas to spruce plantation	12: *Carychium minimum, Stagnicola fuscus, Radix balthica, Anisus spirorbis, Oxyloma pfeifferi, Vertigo pygmaea, Leiostyla anglica, Punctum pygmaeum, Vitrea crystellina, Zonitoides nitidus, Zonitoides excavatus, Deroceras leave*	None
Removal of old buildings	None	None
Removal of walls and hedges	1: *Vitrea contracta*	None
Change grazing and silage fields to arable crops	2: *Milax gagates, Vertigo pygmaea*	None

Appendix 6. Molluscan species known from County Cork.

Nomenclature follows Moorkens & Speight (2001)
*Species added to Cork list during this survey

Theodoxus fluviatilis	*Pyramidula umbilicata*	*Arion hortensis*
Acicula fusca	*Columella edentula*	*Arion distinctus*
Bithynia tentaculata	*Columella aspera*	*Arion owenii*
Potamopyrgus antipopdarum	*Vertigo antivertigo*	*Arion intermedius*
Peringia ulvae	*Vertigo substriata*	*Cochlicella acuta*
Valvata cristata	*Vertigo pygmaea*	*Ashfordia granulate*
Valvata piscinalis	*Vertigo lilljeborgi*	*Trichia hispida*
Acroloxus lacustris	*Vertigo angustior*	*Trichia striolata*
Galba truncatula	*Clausilia bidentata*	*Helicella itala*
Stagnicola palustris	*Balea perversa*	*Candidula intersecta*
Omphiscola glabra	*Cecilioides acicula*	*Zenobiella subrufescens*
Radix auricularia	*Testacella maugei*	*Cernuella virgata*
Radix balthica	*Testacella haliotidea*	*Arianta arbustorum*
Lymnea stagnalis	*Testacella scutulum*	*Helicigona lapicida*
Physa fontinalis	*Punctum pygmaeum*	*Theba pisana*
*Physella acuta**	*Discus rotundatus*	*Cepea nemoralis*
Aplexa hypnorum	*Vitrea crystallina*	*Cepea hortensis*
Planorbarius corneus	*Vitrea contracta*	*Cornu aspersum*
Planorbis planorbis	*Euconulus fulvus*	*Margaritifera margaritifera*
Planorbis carinatus	*Euconulus praticola*	*Anodonta cygnaea*
Anisus spirorbis	*Zonitoides nitidus*	*Sphaerium corneum*
Bathyomphalus contortus	*Zonitoides excavatus*	*Musculium lacustre*
Gyraulus albus	*Oxychilus cellarius*	*Pisidium amnicum*
Gyraulus crista	*Oxychilus draparnaudi*	*Pisidium casertanum*
Hippeutis complanatus	*Oxychilus alliarius*	*Pisidium personatum*
Ancylus fluviatilis	*Aegopinella pura*	*Pisidium obtusale*
Myosotella myosotis	*Aegopinella nitidula*	*Pisidium lilljeborgii*
Carychium minimum	*Nesovitrea hammonis*	Pisidium hibernicum
Carychium tridentatum	*Milax gagates*	*Pisidium nitidum*
Succinea putris	*Tandonia rustica*	*Pisidium milium*
Succinella oblonga	*Tandonia budapestensis*	*Pisidium subtruncatum*
Oxyloma elegans	*Tandonia sowerbyi*	*Pisidium pulchellum*
Cochlicopa lubrica	*Semilimax pyrenaicus*	
Cochlicopa lubricella	*Vitrina pellucida*	
Lauria cylindracea	*Boettgerilla pallens*	
Leiostyla anglica	*Limax maximus*	
Vallonia costata	*Limax cineroniger*	
Vallonia excentrica	*Limacus flavus*	
Acanthinula aculeata	*Limacus maculatus*	
Spermodea lamellata	*Lehmannia marginata*	
Pupilla muscorum		
		126 species (14 bivalves, 26 freshwater gastropods,30 slugs, 56 snails)