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Community Analysis of the Land Snail (Gastropoda) on the island of Ruissalo, SW Finland

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In the present analysis, I will examine concomitant species in designated sample areas as well as -type the number and relations of the land snail species in five deciduous-type forests. I will use the land snail populations on the island of Ruissalo (co-ord. 671:323) in Turku, SW Finland as the data for my analysis.

1. Methods

The samples (Routio 1991, 1993, 1994, 1998, 2003, 2004, 2007) were taken on Ruissalo between the years 1991 and 2009, 102 of which were taken in forests (Table1). There are 72 samples from deciduous forests. Table 2 depicts the type of biotope the species needs for its habitat and mutual relationships among the species.

A total of 1,725 liters of forest debris and soil were analyzed. Samples of the forest debris were taken using the same method every year. They were evenly gathered from an area, with a radius of 3 meters, vertically to a depth of 0–5 cm. The surface soil and the debris were sieved and the snails were picked from the sieved material with a fine brush.

2. Concomitant species in sample areas

Comparisons between land snail communities can be made by examining the place a sample was taken without comparing biotopes and by comparing the occurrence of a species in the company of another, i.e. the correlation of occurrence in the sample areas (Table 1, Fig. 1). In 102 of the sample areas on Ruissalo, the most common species was *Nesovitrea hammonis*, occurring in 75 sample areas. *Cochlicopa lubrica* followed with 67 and *Euconulus fulvus* in 59 samples. The most common snail as regards the number of specimens was *Zonitoides nitidus*, occurring in 15 sample areas. Only one species occurred in three samples: *Zonitoides nitidus*, *Nesovitrea hammonis* and *Succinea putris*.

The species mentioned first has an occurrence correlation of 100–99% as compared to the latter: *V.pul* / *C.lub*, *V.cos* / *C.lub*, *V.pus* / *N.ham*, *C.lam* / *N.ham*, *E.str* / *N.ham*, *A.nit* / *C.lub* and *N.pet* / *N.ham*.

In Table 1, you can see that a 93–90% occurrence correlation is: *V.sub* / *C.lub*, *Z.nit* / *E.ful*, *E.str* / *C.bid, V.pus* / *C.lub, V.pus* / *P.pyg, V.pus* / *C.bid*. There is also an extremely clear correlation compared to the latter: *C.ede* / *F.fru* (83%), *F.fru* / *V. pel* (68%), *Z.nit* / *S.put* (47%), *F.fru* / *T.his* (77%), *V.pul* / *V.sub* (73%) and *C.lam* / *V.pus* (43%).

However, it is very rare that *N.ham* / *Z.nit* (8%), *C.bid* / *Z.nit* (9%), *Z.nit* / *C.asp* (7%), *V.pel* / *C.ede* (9%), *V.pel* / *V.pul* (9%) and *V.sub* / *V.pus* (7%) occur together with the firstly mentioned in the same small biotopes. For example, no occurrences of *C.ede* / *Z.nit*, *V.pus* / *Z.nit*, *T.his* / *Z.nit*, *C.asp* / *V.pul*, *S.put* / *C.ede*, *S.put* / *C.asp*, *S.put* / *V.pus*, *A.nit* / *V.cos*, *A.nit* / *C.ede* and *A.nit* / *V.pus* together were found in the sample areas.

Table 1. Occurrence of the land snail species on the island of Ruissalo in relation to each other/occurrence correlation. The more common species (21) were examined. The species are arranged from the most common to the most rare. The numbers are percentages and the number of sample areas is in parentheses (n = 102 sample areas).

	Σ		Z.nit	N.ham	C.lub	P.pyg	E.ful	C.bid	D.rud	N.pet	V.pel	V.sub	V.pul	C.ede	C.asp	F.fru	V.cos	V.pus	C.lam	E.str	S.put	A.nit	T.his
			%(n)																				
Z.nit	15	%(n)		40(6)	**87(13)**	73(11)	**93(14)**	33(5)	53(8)	33(5)	40(6)	40(6)	40(6)	**0**	**7(1)**	27(4)	13(2)	**0**	13(2)	**7(1)**	**47(7)**	**0**	**0**
N.ham	75		**8(6)**		75(56)	56(42)	65(49)	61(46)	56(42)	61(46	60(45)	28(21)	11(8)	13(10)	29(16)	43(32)	8(6)	13(10)	19(14)	12(9)	9(7)	4(3)	15(11)
C.lub	67		19(13)	75(56)		64(43)	76(51)	63(42)	54(36)	63(42	55(37)	37(25)	22(15)	13(9)	29(16)	48(32)	12(8)	13(9)	15(10)	12(8)	15(10)	3(2)	16(11)
P.pyg	52		21(11)	81(42)	83(43)		79(41)	67(35)	58(30)	62(32	52(27)	40(21)	23(12)	21(11)	25(13)	46(24)	12(6)	17(9)	19(10)	15(8)	17(9)	4(2)	17(9)
E.ful	59		24(14)	83(49)	**86(51)**	78(41)		**78(41)**	66(39)	54(32	51(30)	37(22)	22(13)	15(9)	29(17)	46(27)	12(7)	14(8)	17(10)	10(6)	17(10)	3(2)	17(10)
C.bid	53		**9(5)**	87(46)	79(42)	66(35)	77(41)		57(30)	51(27	58(31)	40(21)	23(12)	17(9)	28(15)	57(30)	11(6)	17(9)	21(11)	17(9)	11(6)	4(2)	21(11)
D.rud	47		15(7)	89(42)	76(36)	63(30)	**83(39)**	63(30)		62(29	51(24)	40(19)	15(7)	13(6)	30(14)	47(22)	13(6)	11(5)	19(9)	13(6)	15(7)	4(2)	9(4)
N.pet	47		11(5)	**99(46)**	89(42)	68(32)	68(32)	57(27)	62(29)		49(23)	36(17)	11(5)	17(8)	23(11)	36(17)	6(3)	15(7)	23(11)	15(7)	6(3)	4(2)	15(7)
V.pel	53		11(6)	85(45)	70(37)	51(27)	57(30)	58(31)	45(24)	43(23		21(11)	**9(5)**	**9(5)**	21(11)	53(28)	9(4)	9(5)	13(7)	9(5)	15(8)	4(2)	13(7)
V.sub	27		22(6)	78(21)	**93(25)**	78(21)	81(22)	78(21)	70(19)	63(17	41(11)		**41(11)**	26(7)	26(7)	55(15)	19(5)	7(2)	22(6)	19(5)	22(6)	7(2)	26(7)
V.pul	15		40(6)	53(8)	**100(15)**	80(12)	**87(13)**	80(12)	47(7)	33(5)	33(5)	**73(11)**		20(3)	**0**	67(10)	27(4)	**7(1)**	13(2)	13(2)	33(5)	**0**	40(6)
C.ede	12		**0**	83(8)	75(9)	**92(11)**	75(9)	75(9)	50(6)	67(8)	42(5)	58(7)	25(3)		33(4)	**83(10)**	12(1)	33(4)	42(5)	17(2)	**0**	**0**	33(4)
C.asp	19		2(1)	87(17)	84(16)	68(13)	**89(17)**	**79(15)**	**74(14)**	58(11	58(11)	37(7)	**0**	21(4)		58(11)	11(2)	21(4)	21(4)	11(2)	**0**	5(1)	11(2)
F.fru	41		10(4)	78(32)	78(32)	58(24)	66(27)	73(30)	54(22)	41(17	**68(28)**	36(15)	24(10)	24(10)	29(11)		10(4)	17(7)	22(9)	12(5)	17(7)	2(1)	24(10)
V.cos	8		25(2)	75(6)	**100(8)**	75(6)	88(7)	75(6)	74(6)	37(3)	50(4)	62(5)	50(4)	**13(1)**	25(2)	50(4)		25(2)	13(1)	25(2)	25(2)	**0**	25(2)
V.pus	10		**0**	**100(10)**	**90(9)**	90(9)	80(8)	**90(9)**	50(5)	70(7)	50(5)	20(2)	10(1)	40(4)	40(4)	70(7)	20(2)		**60(6)**	30(3)	**0**	**0**	20(2)
C.lam	14		7(1)	**100(14)**	71(10)	71(10)	71(10)	78(11)	64(9)	**78(11**	50(7)	43(6)	14(2)	36(5)	29(4)	64(9)	**7(1)**	**43(6)**		21(3)	7(1)	7(1)	21(3)
E.str	10		10(1)	**100(10)**	80(8)	80(8)	60(6)	**90(9)**	60(6)	70(7)	50(5)	60(6)	20(2)	30(3)	30(3)	50(5)	20(2)	30(3)	30(3)		10(1)	10(1)	40(4)
S.put	13		**54(7)**	54(7)	77(10)	69(9)	77(10)	46(6)	54(7)	23(3)	61(8)	46(6)	38(5)	**0**	**0**	54(7)	15(2)	**0**	8(1)	8(1)		**0**	31(4)
A.nit	3		**0**	67(2)	**100(3)**	67(2)	67(2)	67(2)	67(2)	67(2)	67(2)	67(2)	**0**	**0**	33(1)	33(1)	**0**	**0**	33(1)	33(1)	**0**		**0**
T.his	13		**0**	85(11)	85(11)	69(9)	77(10)	85(11)	38(5)	54(7)	54(7)	54(7)	46(6)	31(4)	23(3)	**77(10)**	15(2)	15(2)	23(3)	31(4)	31(4)	**0**	
X = %			14,4	79,9	83,9	70,8	75,8	69,8	57,7	54,5	52,0	43,8	22,2	17,6	24,5	53,2	11,6	15,4	22,3	15,7	14,1	2,9	18,8

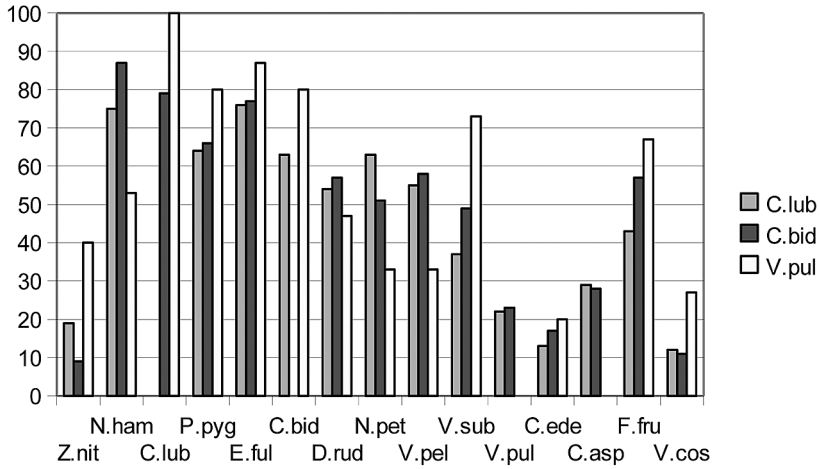

Fig.1. *Cochlicopa lubrica*, *Clausilia bidentata* and *Vallonia pulchella* percentages of occurrence in relation to the species indicated on the bottom of the picture.

3. Species relations according to biotope

The composition of the vascular plant species has traditionally been used to describe the habitat requirements of the land snail. The snail species of Finland's varied forest types have been researched very little (Luther 1901, Mäkelä 1938, Saarinen 1956, Siponen 1957, Suomalainen 1986). The same is true for regional comparison (Karling & Lähdesmäki 1995). Comparing species according to biotope (Table 2, Figs. 2, 3) reflects the needs of land snails as regards their habitat.

A number 5 in the "Frequency" column in Table 2 indicates that the species is one that occurs in all types of deciduous woodlands. Species marked with a number 1 are therefore fastidious with regard to their biotope. None were found in Gfit-type, cultural woodlands, only a species, which is generally found in such areas, with a frequency of 1 (Table 2). Five species were only found in Omat-HeOT-types and seven LT-types.

Nesovitrea hammonis was the most abundant species in dry woodlands (VRT, Melat) with a proportion of 29.6%. *Punctum pygmaeum* had a proportion of 20.8%. The number of species in dry woodlands was no more than 18, and the number of individual specimens was very small. Only one snail shell was found out of two forest debris samples. A washed-away slope of dry clay where

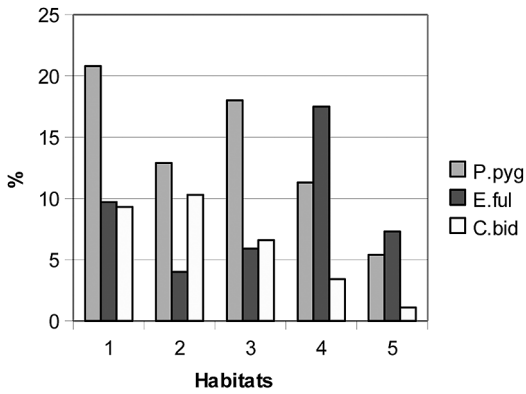

Fig. 2. Land snail species *Punctum pygmaeum, Euconulus fulvus* and *Clausilia bidentata* on the island of Ruissalo in different types of broadleaved woodlands.

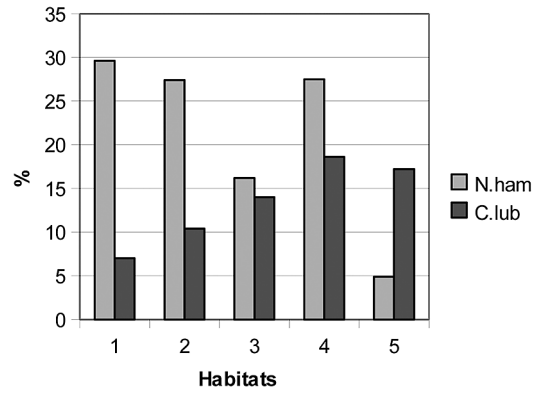

Fig. 3. Land snail species *Nesovitrea hammonis* and *Cochlicopa lubrica* on the island of Ruissalo in different types of broadleaved woodlands.

Table 2. The land snails on the island of Ruissalo in five different types of woodlands. They are arranged from the driest type of forest (1) to the moistest (5). The total number of species includes all of the species found in deciduous woodland areas. Species with a frequency of 1 and which are less than 1% are not included (n= 4,803).

	1		2		3		4		5				
	Dry herb-rich woodland VRT, Melat		Moist herb-rich woodland Omat, HeOT		Cultural herb-rich woodland GFit		Fern herb-rich woodland FT, MatT, AthOT		Alder type herb-rich woodland LT		X=	Ind.	Fre-
	%	Ind.	%	Ind.	%	Ind.	%	Ind.	%	Ind.	%	total	que
N.ham	29,6	131	27,4	281	16,2	44	27,5	207	4,9	113	16,2	776	5
C.lub	7,0	31	10,4	107	14,0	38	18,6	140	17,2	396	14,8	712	5
P.pyg	20,8	92	12,9	129	18,0	49	11,3	85	5,4	125	10,0	480	5
E.ful	9,7	43	4,0	41	5,9	16	17,5	132	7,3	168	8,3	400	5
C.bid	9,3	41	10,3	106	6,6	18	3,4	26	1,1	26	4,5	217	5
D.rud	3,1	14	6,7	69	4,0	11	6,1	46	3,1	72	4,2	201	5
V.sub	1,1	5	1,9	19	0,7	2	5,3	40	1,9	45	2,3	111	5
V.pel	3,8	17	2,8	29	1,5	4	0,4	3	2,3	54	2,1	103	5
N.pet	2,9	13	2,9	30	7,3	20	3,2	24	0,3	6	1,9	93	5
F.fru	3,1	14	2,1	22	5,9	16	0,3	2	0,5	11	1,4	65	5
C.asp	2,7	12	3,4	35	1,8	5	0,7	5	0,1	2	1,2	59	5
V.pul	0,2	1	0,2	2	0,4	1		–	3,9	89	1,9	93	4
C.ede	4,8	21	2,7	28	7,0	19	1,6	12		–	1,7	80	4
V.pus	0,5	2	1,9	19	1,5	4		–	0,04	1	0,5	26	4
T.his	0,5	2	0,4	4	1,8	5		–	0,1	3	0,3	14	4
E.str	0,2	1	0,4	4	1,5	4		–	0,1	3	0,2	12	4
V.cos		–	0,3	3	4,4	12		–	0,3	6	0,4	21	3
Z.nit		–		–		–	2,6	26	49,5	1,144	24,4	1,170	2
C.lam		–	2,3	24	1,5	4		–		–	0,6	28	2
E.ald		–	0,5	5		–	1,2	9		–	0,3	14	2
A.nit	0,2	1	1,1	11		–		–		–	0,2	12	2
C.lubri	0,2	1	0,8	8		–		–		–	0,2	9	2
V.ron		–	0,4	4	0,4	1		–		–	0,1	5	2
O.all		–	0,1	1		–		–	0.04	1	0,04	2	2
A.acu		–	2,7	28		–		–		–	0,6	28	1
V.lil		–		–		–		–	0,9	21	0,4	21	1
D.rot		–	1,6	16		–		–		–	0,3	16	1
S.put		–		–		–		–	0,6	13	0,3	13	1
Indiv. total		442		1,025		273		754		2,309		4,803	
Spec. total		18		27		19		14		26		35	
Samp. total		18		18		9		9		18		72	

Quercus robur, *Melica nutans* and *Lathyrus linifolius* grow is an unfavorable habitat for snails.

Broadleaf woodlands (Omat, HeOT) have the most diverse number of land snail species in Ruissalo. A total of 1,025 land snails, and as many as 27 different species (Table 2), were found in these types of areas. The moist, sometimes watery *Alnus glutinosa* woodlands come close to that of the aforementioned woodlands with 26 species. The favorable impact of hardwood trees, *Corylus avellana* and other diverse plant life, is evident in broadleaf woodlands. The decomposing layer of forest debris is thick and light, and not only that, it retains moisture well. *Nesovitrea hammonis* was clearly the most common snail species in broadleaf woodlands with a proportion of 27.4%. The proportion of *Punctum pygmaeum* was only 12.9%, and the proportion of *Clausilia bidentata* was as

Table 3. The abbreviations.

S.put	*Succinea putris* (Linnaeus 1758)
C.lub	*Cochlicopa lubrica* (Müller 1774)
C.lubri	*Cochlicopa lubricella* (Rossmässler 1834)
C.ede	*Columella edentula* (Draparnaud 1805)
C.asp	*Columella aspera* (Walden 1968)
V.pus	*Vertigo pusilla* (Müller 1774)
V.sub	*Vertigo substriata* (Jeffreys 1833)
V.ron	*Vertigo ronnebyensis* (Westerlund 1871)
V.lil	*Vertigo lilljeborgi* (Westerlund 1871)
V.cos	*Vallonia costata* (Müller 1774)
V.pul	*Vallonia pulchella* (Müller 1774)
A.acu	*Acanthinula aculeata* (Müller 1774)
P.pyg	*Punctum pygmaeum* (Draparnaud 1801)
D.rud	*Discus ruderatus* (Hartmann 1821)
D.rot	*Discus rotundatus* (Müller 1774)
V.pel	*Vitrina pellucida* (Müller 1774)
A.nit	*Aegopinella nitidula* (Draparnaud 1805)
N.ham	*Nesovitrea hammonis* (Ström 1765)
N.pet	*Nesovitrea petronella* (Pfeiffer 1853)
O.all	*Oxychilus alliarius* (Miller 1822)
Z.nit	*Zonitoides nitidus* (Müller 1774)
E.ful	*Euconulus fulvus* (Müller 1774)
E.ald	*Euconulus alderi* (Reinhardt 1883)
C.lam	*Cochlodina laminata* (Montagu 1803)
C.bid	*Clausilia bidentata* (Ström 1765)
F.fru	*Fruticicola fruticum* (Müller 1774)
T.his	*Trochulus hispidus* (Linnaeus 1758)
E.str	*Euomphalia strigella* (Draparnaud 1801)

much as 10.3%. *Cochlodina laminata* on is most abundant in broadleaf woodlands. This large, cigar-shaped species can also be found in grasslands to some extent; however it has a frequency of just 2.

Cultural woodlands, which are also referred to as grasslands (GFit), clearly have an impact on culture and *Urtica dioica*, *Anthriscus sylvestris* and *Rubus idaeus* commonly form thick growths in these woodlands. Compared to other woodland types, the *Trochulus hispidus*, which prefers to reside near compost heaps and edges of gardens, was the most common species. *Columella edentula* is, in proportion, the most common species in cultural woodlands. *Fruticicola fruticum* is a species that climbs high on large vascular plants and therefore can be easily seen. Its choice of habitat is the cultural grassland with a frequency of 5. *Euomphalia strigella* is found in many types of woodlands with a frequency of 4.

There are *Matteuccia* and *Dryopteris* types of fern spruce woodlands (FT, MatT, AthOT) in Ruissalo. The extensive ostrich fern woodland is part of an alkali, diabase area. On the other hand, all of the large spruce trees in the fern woodlands in Ruissalo produce acidic needle debris. This limits the number of the species, although the number of each specimen stays rather high due to the moist ground. *Euconulus fulvus* occurs more frequently in fern woodlands dominated by spruce (Fig. 2).

Larger numbers were found in alder woodlands (LT) where the dominant species is *Zonitoides nitidus*. The total number of specimen in the examined alder woodlands rose to 2,271, 49.5% of which was *Zonitoides nitidus*. *Zonitoides nitidus* is indeed a hydrophilic land snail species. It has a frequency of 2. *Cochlicopa lubrica*, which accounted for 17.2% of the species in the alder woodlands, thrives well in many types of biotopes. *Vallonia pulchella* (3.9%) lives in moist alder woodlands especially.

The Vertigo species is at its most diverse in lush, moist alder woodlands where five species were found. *Vertigo substriata* has a frequency of 5. *Succinea putris* is abundant in moist alder woodlands. The lack of *Columella edentula* and the scarcity of *Columella aspera* in the alder woodlands of Ruissalo is a slight cause for concern. On the other hand, the situation is the same as in Askola's study (Suomalainen 1986).

The commonness and abundance of Finnish land snails varies in different forest types if the snails of Finnish forests are given a general overview from dry pine forest to moist, herb-rich woodlands (Mäkelä 1938, Saarinen 1956, Siponen 1957, Suomalainen 1986). According to this study, the different types of herb-rich woodlands found on the Ruissalo island in Turku contain species that are specialised in only a certain type or a few types of herb-rich woodland. The abundance of many species varies considerably with different types of herb-rich woodland. For example, the two most common land snails in Ruissalo, *Nesovitrea hammonis* and *Cochlicopa lubrica* correlate inversely as regards the types of woodlands (Fig. 3). The woodland types represent different living conditions for the snails. Naturally, they contain many different factors that vary from the point of view of land snails, such as moisture, pH, nutrition, microclimate, cover etc.

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