

Review

# Dormice (Gliridae) in the Diets of Predators in Europe: A Review Broadening Understanding of Dormouse Ecology

Rimvydas Juškaitis

Nature Research Centre, Akademijos 2, LT-08412 Vilnius, Lithuania; rimvydas.juskaitis@gamtc.lt

**Abstract:** This study aimed to evaluate the significance of dormice in the diets of predators in Europe and, as a result, expand the knowledge about dormouse ecology. A total of 535 sources containing information on dormice in the diets of predators were analysed. Countries of Southern and Central Europe stand out with the largest numbers of target sources. Dormice were recorded in the diets of 54 predator species: 23 mammals, 11 owls, 16 diurnal birds and 4 reptiles. Owls hunting in forests, particularly the tawny owl *Strix aluco*, are the main dormouse predators. The role of dormice in the diets of predators depends on dormouse abundance, and the highest proportion was recorded in the Mediterranean region, where edible dormice *Glis glis* are abundant. In particular periods, dormice may be an alternative prey for owls and some other predators. Dormice were seldom recorded in the winter diets of predators, especially in mammals, contrary to what was previously thought. Records of dormice in the winter diets of owls confirm that dormice leave their hibernacula during arousals in the thaw periods. The presence of dormice in the diets of diurnal birds suggests that nocturnal dormice may also be active in the daytime.

**Keywords:** birds of prey; diet of predators; dormice; Gliridae; mammalian predators; owls; reptiles



**Citation:** Juškaitis, R. Dormice (Gliridae) in the Diets of Predators in Europe: A Review Broadening Understanding of Dormouse Ecology. *Diversity* **2023**, *15*, 52. <https://doi.org/10.3390/d15010052>

Academic Editor: Michel Baguette

Received: 23 November 2022

Revised: 19 December 2022

Accepted: 27 December 2022

Published: 2 January 2023



**Copyright:** © 2023 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Dormice belong to one of the oldest families of living rodents, represented by 29 species distributed in Europe, Asia and Africa [1]. Dormice are known for their ability to hibernate or go into torpor when environmental conditions are unfavourable. In the northern parts of their range, dormouse hibernation may last up to eight months. Dormice are characterised by longevity in comparison with other rodents of similar size and low reproduction rates [1–3].

Five dormouse species live in Europe: the hazel dormouse *Muscardinus avellanarius*, the edible dormouse *Glis glis*, the forest dormouse *Dryomys nitedula*, the garden dormouse *Eliomys quercinus* and the mouse-tailed dormouse *Myomimus roachi*. Of these, two species are listed in the IUCN Red List: the mouse-tailed dormouse as Vulnerable and the garden dormouse as Near Threatened [4]. The dormouse abundance and protection status vary in different parts of their ranges, and the same dormouse species are common and abundant in some countries, but they are included in the national Red Lists of other countries [1,5,6].

The role of dormice in ecosystems and the economic significance for humans are not unambiguous and depend on their abundance as well as their body size. Among all dormice, the largest species—the edible dormouse—has the greatest impact on humans. In regions where edible dormice are abundant (e.g., Italy, Caucasus and Moldova), they can do some damage to the harvest of fruit trees (grapes, pears, hazels, walnuts, etc.) [1,3]. Edible dormice can also do some damage to trees by stripping the bark and the outer part of the xylem from the trunks and branches of both broadleaves and conifers [7,8]. Edible dormice as well as garden and forest dormice may easily penetrate houses and cause some damage, mostly to stored food, wooden constructions or electrical installations, and disturb the sleep regime of household owners during nocturnal activity [7,9,10].

In Mediterranean Europe (Italy, Slovenia and Croatia), as well as in Russia and Ukraine, edible dormice were hunted for food, fur and medical utilization. Nowadays, traditional

dormouse hunts are still popular in Slovenia and Croatia, but have become more of a social activity than hunting for sustenance [3,5,11].

Almost all dormouse species are forest animals and prefer to dwell in tree holes or their artificial substitutes—nest boxes. As cavity dwellers, dormice are known to be competitors with small hole-nesting birds, having a significant influence on their reproductive success [12–14]. Dormice also provide some other ecosystem functions, such as invertebrate predation and the eating of tree seeds [15–19]. Some dormouse species have been identified as reservoir hosts for the Lyme disease spirochete [1].

Dormice are listed among the prey items of many mammal and bird species, and their remains found in the diets of predators are often used in dormouse distribution studies (e.g., [20,21]). However, the significance of dormice as a food source for predators is unclear. Usually, it is only indicated that dormice can be a supplemental food for some predatory mammals and birds, but they are considered a minor food source [2,3,22,23]. However, in some areas and in particular periods, dormice may be important and even alternative prey for some predator species (e.g., [24–27]).

The impact of predators may be significant on rare dormouse species of conservation concern whose populations are not abundant. It is speculated that the wild boar *Sus scrofa* and the red fox *Vulpes vulpes* are important dormouse predators in winter, and they can reduce hazel dormouse abundance [28,29]. Predation by owls and other predators may be the main reason for the high summer mortality of hazel dormouse populations [6].

So far, predation on dormice in Italy has only been reviewed by Scaravelli and Aloise [30], and few articles on dormice in the diet of owls in particular regions have been published [31–33]. Lists of predators of edible, hazel and garden dormice are presented in publications by Kryštufek [5], Juškaitis [6] and Moreno [34], but some of them do not cover the entire distribution range and need to be supplemented. To date, nobody has tried to evaluate the role of dormice in the diets of different predator species across Europe, and this topic remains largely unexplored.

The aim of the present study was to collect available information on dormice in the diets of potential predators (mammals, birds and reptiles) in Europe in order to:

1. Review the geographic variation in predation on dormice in Europe;
2. Identify the most important dormouse predators and compile lists of predators of separate dormouse species;
3. Examine cases in which dormice made up noteworthy proportions (>10%) in the diets of predators;
4. Evaluate the occurrence of dormice in the winter diets of predators.

## 2. Materials and Methods

A search for published data on dormice in the diets of potential predators was performed using the Google Scholar database. Google Scholar was used because it includes information sources not only in English (as in the Clarivate Analytics Web of Science and Scopus databases), but also in other languages, as well as publications in local journals and the so-called “grey literature”.

The keywords used for the search in English were “common name of the potential predator” or “Latin name of the potential predator” and “diet” or “foraging”. An analogous search was carried out using equivalent keywords in German, French and Russian languages because the majority of target publications in these languages did not contain English summaries. Sources that matched these search criteria were screened using the keywords “dormouse” or “dormice” (in the respective language) and the Latin names of dormouse species living in the area where the study was carried out. Tables of the diet compositions of predators were screened to see whether they contain dormouse species. Secondly, the literature mentioned in these articles was screened to identify new references. Primary sources were selected from review papers (e.g., [30,34–37]). Some old publications not available on the internet were obtained as paper copies (e.g., [38–40]).

Based on these searches, we obtained data from 530 sources, such as journal articles, short communications, theses, dissertations, technical reports, book chapters and websites. Furthermore, 5 personal communications from dormouse researchers on this topic were obtained. A total of 535 sources containing information on dormice in the diets of predators were collected and analysed.

Publications in local journals and the “grey literature” provided the most information on the topic of this research, as they usually contained lists of prey items and quantitative information on the compositions of predator diets. Research articles on different aspects of predators’ diets published in journals included in the Web of Science or Scopus databases seldom contained such information (sometimes in Appendices or Supplementary Materials) because dormice were not usually specified but incorporated among small rodents.

Only “positive publications”, i.e., when the diet of the predator included at least one dormouse specimen, were used for analysis. Publications in which the diets of predators did not include dormice were not analysed because dormice could be absent in the diet of a predator for two reasons that could not be identified: (1) the predator does not feed on dormice although they are present in the study area, and (2) the predator cannot feed on dormice because they are absent in the study area.

Information on dormice in the diets of predators presented in the sources analysed was very different, from a simple mention of the fact of predation by a particular predator on a specific dormouse species in the text to detailed tables of diet compositions containing diet descriptors, such as the following:

1. The numbers of prey items recorded;
2. The frequency of occurrence—the percentage of food items found in the total sample;
3. The relative frequency of occurrence—the percentage of faeces, pellets or stomach samples in which the particular food item was found;
4. The proportion of biomass consumed—the percentage of consumed biomass composed of one type of food item.

Irrespective of the presence of quantitative characteristics, all sources were used for the evaluation of geographic variation in predation on dormice, the compilation of a list of predators of specific dormouse species and the estimation of the number of sources on predation by a particular predator on specific dormouse species. For the evaluation of the proportions of dormice in the diets of predators, only sources containing quantitative information—the frequency of occurrence or the percentage of biomass consumed—were used.

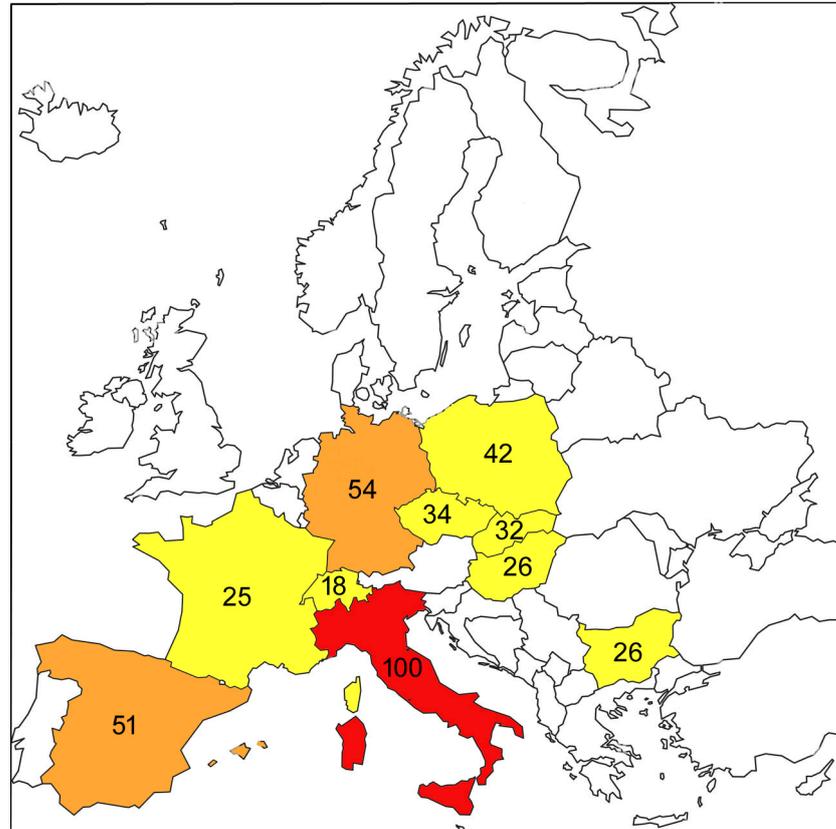
In most of these studies, the total diets of predators, including invertebrates, was studied, while in others, only vertebrates and, in some cases, only mammals were analysed. This circumstance is indicated in the text when comparing the proportions of dormice in the diets of predators. Cases in which the dormouse proportion in the predator diet exceeded 10% by frequency of occurrence or proportion of biomass consumed were considered noteworthy proportions, and they are discussed in the respective sections of the paper. The common and scientific names of animals described in this article are taken from the IUCN Red List of Threatened Species [4].

### 3. Results and Discussion

#### 3.1. Geographic Variation in Predation on Dormice in Europe

Countries of Southern and Central Europe—Italy, Germany, Spain, Poland, Czech Republic, Slovakia, Hungary, Bulgaria and France—stand out with the largest numbers of sources containing information on dormice in the diets of predators (Figure 1). Italy is the obvious leader in the number of such sources despite the fact that a search for information in the Italian language was not carried out. Our results show that the diets of potential dormouse predators are well investigated in Italy. A review paper on predation on dormice in Italy was published by Scaravelli and Aloise [30], and some data from previous publications are presented here. There are many publications on the diets of predators in local journals in Germany, but some of them are not available on the internet. Meanwhile,

many recent local publications with English summaries on the diet composition of predators in Poland are available online. For Spain, summarised information on predators of the garden dormouse, comprising as many as 32 references, is presented in the account for this species published by Moreno [34].



**Figure 1.** Top 10 countries by the number of sources on dormice in the diets of predators found.

The presence and proportion of dormice in the diets of predators vary considerably among different countries in Europe. They depend on a series of objective and subjective factors, such as the number of dormouse species, as well as their abundance in different countries, the presence of experts, the level of research and the availability of relevant publications on the internet. For example, the diets of owls and mammalian predators are well investigated in Finland, but dormice have been absent in this country since the garden dormouse went extinct [41]. The presence of experts investigating the diet of particular predator groups (e.g., the diets of owls in Slovakia and Poland and the diets of mammalian carnivores in Hungary) also has a big influence on the number of publications on this topic. Judging by Figure 1, Austria and the countries of the former Yugoslavia appear to be understudied in this respect. According to our experience, many old publications in the Russian language from the countries of the former Soviet Union containing relevant information are not available on the internet.

### 3.2. The Main Dormouse Predators in Europe

In Europe, dormice were recorded in the diets of 54 predator species: 23 mammals, 11 owls, 16 diurnal birds and 4 reptiles (Table 1). The number of predators of specific dormouse species is different and depends on the extent of the dormouse distribution range and some subjective factors, such as the level of research on predator diets in particular countries and the availability of this information on the internet.

**Table 1.** Predators of European dormouse species and number of sources containing information about dormouse species recorded in the diets of particular predators.

Predator Species	Dormouse Species				
	<i>Muscardinus avellanarius</i>	<i>Glis glis</i>	<i>Dryomys nitedula</i>	<i>Eliomys quercinus</i>	<i>Myomimus roachi</i>
	Mammals				
Brown rat <i>Rattus norvegicus</i>				1	
House rat <i>Rattus rattus</i>		1			
Brown bear <i>Ursus arctos</i>		2			
Golden jackal <i>Canis aureus</i>	5	2	1		
Grey wolf <i>Canis lupus</i>	3	2		2	
Domestic dog <i>Canis familiaris</i>				1	
Red fox <i>Vulpes vulpes</i>	15	14	1	6	
Eurasian otter <i>Lutra lutra</i>	2				
Beech marten <i>Martes foina</i>	7	15		6	
Pine marten <i>Martes martes</i>	7	14	1	10	
Eurasian badger <i>Meles meles</i>	2	3	1	2	
Stoat <i>Mustela erminea</i>	1			1	
Least weasel <i>Mustela nivalis</i>	5	3			
Western polecat <i>Mustela putorius</i>	1	1			
American mink <i>Neovison vison</i>	2				
Common genet <i>Genetta genetta</i>		1		7	
Egyptian mongoose <i>Herpestes ichneumon</i>				3	
European wildcat <i>Felis silvestris</i>	8	13	3	6	
Domestic cat <i>Felis catus</i>	8	1		3	
Eurasian lynx <i>Lynx lynx</i>		4		1	
Iberian lynx <i>Lynx pardinus</i>				2	
Northern racoon <i>Procyon lotor</i>	2			1	
Wild boar <i>Sus scrofa</i>	1	3			
	Owls				
Common barn owl <i>Tyto alba</i>	71	26	5	26	5
Eurasian scops owl <i>Otus scops</i>	2	2			
Eurasian eagle owl <i>Bubo bubo</i>	16	44	18	28	
Tawny owl <i>Strix aluco</i>	102	66	27	22	
Ural owl <i>Strix uralensis</i>	7	9	4		
Great grey owl <i>Strix nebulosa</i>	1				
Eurasian pygmy owl <i>Glaucidium passerinum</i>	9				
Little owl <i>Athene noctua</i>	3	1		2	1
Boreal owl <i>Aegolius funereus</i>	58	3	10	16	
Northern long-eared owl <i>Asio otus</i>	47	12	3	5	
Short-eared owl <i>Asio flammeus</i>				1	
	Diurnal birds				
Lesser spotted eagle <i>Clanga pomarina</i>	1	1	1		
Spanish imperial eagle <i>Aquila adalberti</i>				1	
Eastern imperial eagle <i>Aquila heliaca</i>		2	2		
Golden eagle <i>Aquila chrysaetos</i>	1	4		1	
Bonelli's eagle <i>Aquila fasciata</i>				2	
Eurasian sparrowhawk <i>Accipiter nisus</i>	1	1		2	
Northern goshawk <i>Accipiter gentilis</i>		2			
Red kite <i>Milvus milvus</i>				2	
Black kite <i>Milvus migrans</i>				2	
Eurasian buzzard <i>Buteo buteo</i>	2	1	1	1	
Lanner falcon <i>Falco biarmicus</i>	2			1	
Saker falcon <i>Falco cherrug</i>	1				
Eurasian jay <i>Garrulus glandarius</i>		1			
Eurasian magpie <i>Pica pica</i>			1		
Common raven <i>Corvus corax</i>	2	1	1	1	
Common pheasant <i>Phasianus colchicus</i>	1				

Table 1. Cont.

Predator Species	Dormouse Species				
	<i>Muscardinus avellanarius</i>	<i>Glis glis</i>	<i>Dryomys nitedula</i>	<i>Eliomys quercinus</i>	<i>Myomimus roachi</i>
	Reptiles				
Four-lined snake <i>Elaphe quatuorlineata</i>	2				
Aesculapian ratsnake <i>Zamenis longissimus</i>	1	6			
Adder <i>Vipera berus</i>	1	1			
Asp viper <i>Vipera aspis</i>	4	1			
Total number of predator species	37	34	16	31	2
Total number of sources	404	263	80	165	5

The hazel dormouse was recorded in the diets of the highest number of predator species ( $n = 37$ ). The numbers of predator species of the edible dormouse ( $n = 34$ ) and the garden dormouse ( $n = 31$ ) are a little lower (Table 1). Although the forest dormouse has a very wide distribution range, the number of known predators is comparatively small ( $n = 16$ ). The forest dormouse is absent or rare in countries of Southern and Western Europe, where the diets of predators are relatively well studied, and old publications in the Russian language possibly containing such information are not available on the internet.

Owls are the main dormouse predators, particularly the tawny owl *Strix aluco*, the common barn owl *Tyto alba*, the Eurasian eagle owl *Bubo bubo*, the boreal owl *Aegolius funereus* and the Northern long-eared owl *Asio otus* (Table 1). However, the number of dormouse individuals caught and their proportions in diet compositions vary in different owl species. Owl species hunting in forests, primarily the tawny owl, are the main dormouse predators according to the number of dormouse individuals caught [31,32,42]. In Slovakia, dormice were found in the diets of seven owl species, and 84.84% of all dormice (four species) were caught by tawny owls [32]. The tawny owl is a generalist species and very adaptable to different food sources and environmental conditions. Thus, in its diet, many species of different sizes, ecologies and taxonomies can be found, including different dormouse species [37,43,44].

The boreal owl is another owl species that usually hunts in forests [43] and often catches hazel dormice, which can make up a significant portion of its diet. The barn owl hunts mainly in open areas, but it can catch some dormice on the edges of forests and other dormouse habitats [32]. Although there are many sources containing information on dormice in the diet of this owl species (Table 1), the number of dormouse individuals caught is low, usually less than 1% (up to 3.5%) among all prey items. Glue [45] did not find any dormice in the diet of the barn owl in England and Wales among 47 865 prey items recorded, although hazel dormice occur in this region [46]. In the diet of the eagle owl, larger dormouse species, such as edible and garden dormice, may be important prey items in some areas of Southern Europe (see Table 2), but not in the northern part of the range (e.g., [47]). There are many sources on hazel dormice in the diet of the long-eared owl (Table 1), but the number of dormice caught is low, as in the case of the barn owl, usually less than 1% among all prey items.

Dormice were recorded among prey items of as many as 18 species of diurnal birds (Table 1), but their proportions were usually very low (0.01–1.7%), except for 3 cases (6.3–11.7%) among 42 sources. The highest number and proportion of the edible dormouse were recorded in the diet of the golden eagle *Aquila chrysaetos* (see Table 2). Dormice were preyed upon not only by diurnal birds of prey but also by some corvids, such as the common raven *Corvus corax* and some other species (Table 1). The presence of dormice in the diets of diurnal birds confirms that dormice, which are considered to be predominantly nocturnal animals [1–3], may also be active and leave their shelters in the daytime.

Among mammals, the red fox, the pine marten *Martes martes*, the beech marten *Martes foina* and the European wildcat *Felis silvestris* are the most frequent dormouse predators (Table 1). However, the proportion of dormice found among the prey items of these mammalian predators is not high, seldom exceeding 10% (see Table 2).

Solitary dormouse individuals were recorded in the diets of four reptile species, most often in the diet of the Aesculapian ratsnake *Zamenis longissimus* and the adder *Vipera berus* (Table 1). In studies on the diets of reptiles, up to four individuals of dormice were found, and they formed up to 6.2% of all prey items recorded [48].

### 3.3. Noteworthy Proportions of Dormice in Diets of Predators

According to the present study, the proportion of dormice in the diets of different predators is usually rather low, but it varies depending on dormouse abundance in specific regions. In regions where dormice are abundant, such as the Alps, they may compose more than 10% by frequency of occurrence and, in exceptional cases, even more than 50% by biomass of predators' diets (Table 2). In particular, edible dormice may be important prey for predators because of their high body mass compared to other dormice [5]. In autumn, when edible dormice accumulate fat reserves for hibernation, their body weight is several times higher than that of voles and mice fed on by medium-sized predators, such as the tawny owl, the Ural owl *Strix uralensis* or the pine marten. The highest proportions of dormice in the diets of predators were recorded in regions where edible dormice are abundant and some other dormouse species, primarily hazel dormice, live in sympatry (Table 2). Such is the case in the countries of the Mediterranean region, especially Italy, as well as Croatia and Slovenia, where the population density of the edible dormouse can reach up to 15–80 ind./ha in autumn (review in [49]).

**Table 2.** Cases where proportion of dormice in the diets of predators reached 10% by number of individuals captured or by biomass consumed. Scientific names of dormouse species are abbreviated: G. g.—*Glis glis*; M. a.—*Muscardinus avellanarius*; D. n.—*Dryomys nitedula*; E. q.—*Eliomys quercinus*.

Predator Species	Dormouse Species	Proportion in the Diet		Country	Region/Habitat/Season	References
		by No. of Individuals, %	by Biomass, %			
<i>Strix aluco</i>	G. g.	13.6	71.2	Italy	Central Italy, beech forest	[50]
<i>Strix aluco</i>	G. g. + M. a.	22.9	56	Italy	Italian Alps, 3 localities	[51]
<i>Strix aluco</i>	G. g.	44	81.2	Italy	Italian Alps, coppice woodland	[24]
<i>Strix aluco</i>	G. g. + M. a.	9.2	27.3	Italy	Italian Alps, broadleaved forest	[24]
<i>Strix aluco</i>	G. g. + M. a. + E. q.	20.9	43	Italy	Italian Alps, mixed high forest	[24]
<i>Strix aluco</i>	G. g. + M. a.	10.7	51.2	Italy	Sicily, beech forest	[52]
<i>Strix aluco</i>	G. g. + M. a.	7.3	30.6	Slovenia	13 localities	[53]
<i>Strix aluco</i>	M. a. + G. g.	14.97		Belarus	Brest region, forest	[54]
<i>Strix aluco</i>	M. a. + G. g.	10.7		Slovakia	Kremnické vrchy Mts, forest	[55]
<i>Strix aluco</i>	M. a.	10.24		Slovakia	Wet cold mountains	[37]
<i>Strix aluco</i>	M. a.	14.25		Slovakia	Chočské vrchy Mts.	[37]
<i>Strix aluco</i>	M. a.	16.24		Slovakia	Muránska planina Mts.	[37]
<i>Strix aluco</i>	M. a. + G. g.	10.85		Slovakia	Veľká Fatra Mts.	[37]
<i>Strix aluco</i>	M. a. + G. g.	11.04		Slovakia	Voniaca valley	[37]
<i>Strix aluco</i>	M. a. + G. g.	17.84		Romania	Apuseni Mts., 4 localities	[37]
<i>Strix aluco</i>	G. g.	11.8		Russia	Caucasus	[37]
<i>Strix aluco</i>	G. g. + M. a. + D. n.	19.7		Slovenia	Topla Reber	[37]
<i>Strix aluco</i>	G. g. + M. a. + D. n.	26.3		Montenegro	Tara canyon	[37]
<i>Strix aluco</i>	G. g. + M. a. + E. q.	12.65		France	Savoy Alps	[37]
<i>Strix aluco</i>	G. g. + M. a. + D. n.	10.8		Bulgaria	Rocky habitats	[56]
<i>Strix aluco</i>	G. g. + M. a.	13.5–27.5	10–29.5	Serbia	Three localities	[57]
<i>Strix aluco</i>	G. g. + D. n.	18.3	51	Greece	Aliakmonas National Park	[58]
<i>Strix aluco</i>	G. g. + M. a.	22.7		Italy	Tuscany, beech forest	[59]

Table 2. Cont.

Predator Species	Dormouse Species	Proportion in the Diet		Country	Region/Habitat/Season	References
		by No. of Individuals, %	by Biomass, %			
<i>Strix uralensis</i>	G. g.	58.8	93.9	Slovenia	Post-breeding period	[26]
<i>Strix uralensis</i>	Gliridae	4.9	20.6	Slovenia	Non-breeding period	[60]
<i>Bubo bubo</i>	G. g.	22.4	8.5	Italy	Italian Alps, 3 localities	[51]
<i>Bubo bubo</i>	G. g.	22.8		Italy	Italian Alps	[61]
<i>Bubo bubo</i>	Gliridae	28.5		Italy	Italian Alps	[62]
<i>Bubo bubo</i>	G. g. + E. q.	15.6		France	France Alps	[63]
<i>Bubo bubo</i>	G. g. + E. q.	4.5–14.8	1.1–5.7	France	Alpes Maritimes	[64]
<i>Bubo bubo</i>	G. g.	up to 37.7		Slovenia	Coastal area	[65]
<i>Aegolius funereus</i>	M. a.	16.3		Germany	Siegerland, coppiced oak wood	[66]
<i>Aegolius funereus</i>	M. a.	0–14.6		Czech Republic	Nine localities	[67]
<i>Aegolius funereus</i>	M. a.	60.87		Czech Republic	South Bohemia, one nestbox	[68]
<i>Aegolius funereus</i>	M. a.	17.5		Belarus	Brest region	[69]
<i>Aegolius funereus</i>	M. a.	11.4	10.4	Ukraine	Polesia, 2 localities	[70]
<i>Aegolius funereus</i>	M. a.	12.33	10.7	Serbia	High-mountain coniferous forests	[27]
<i>Aegolius funereus</i>	M. a. + D. n.	12.03		Slovakia	The whole country	[37]
<i>Aquila chrysaetos</i>	G. g. + M. a.	11.7		Italy	Italian Alps	[71]
<i>Aquila chrysaetos</i>	G. g.	10.5		France	Provence	[72]
<i>Felis silvestris</i>	G. g. + M. a. + E. q.	7.1	19.5	Italy	Woodland/open areas	[73]
<i>Martes foina</i>	G. g.	31.43	40.26	Italy	Val Grande National Park Wood	[74]
<i>Martes foina</i>	G. g. + M. a.	17.1		Italy	Quercus-Carpinetum	[75]
<i>Martes foina</i>	G. g. + M. a. + Gliridae	12.8	9.8	Italy	Tuscany region, wood/rural	[76]
<i>Martes martes</i>	E. q.	10.3	9.5	Italy	Sardinia	[77]
<i>Martes martes</i>	E. q.	18.3	15.2	Italy	Minorca, in March–April	[78]
<i>Mustela erminea</i>	E. q.	10.77	9.23	Italy	Italian Alps	[79]
<i>Vulpes vulpes</i>	G. g.	9.9		Russia	Caucasus	[38]
<i>Vulpes vulpes</i>	M. a. + G. g.	up to 11.8		Germany	Foothills of Bavarian Alps	[80]
<i>Lynx lynx</i>	G. g.	18	6.9	SloveniaCroatia	Northern Dinaric Mts.	[25]

The Italian Alps, where edible dormice are abundant and hazel dormice as well as garden dormice occur, stand out with the highest dormouse proportion in the diets of different predators, such as the tawny owl, eagle owl, beech marten and stoat. In addition, in neighbouring Slovenia, edible dormice formed noteworthy proportions in the diets of the tawny owl, Ural owl, eagle owl and Eurasian lynx *Lynx lynx* (Table 2). Studies carried out in some regions of Italy (Italian Alps, Central Italy and Sicily) revealed especially high proportions (51–81% by biomass) of dormice in the diet of the tawny owl (Table 2). When the abundance of other rodents was decreased, edible dormice also dominated the diet of the tawny owl in the Caucasus [38]. Locally, in the post-breeding period, edible dormice may also form the bulk of the diets of other owl species, for example, 58.8% by the number of prey items and even 93.9% by biomass in the diet of the Ural owl in Slovenia [26]. Where edible dormice are abundant, they are important prey items for the eagle owl, which prefers to hunt for larger prey [37,81]. In the Italian and French Alps, edible dormice were among the dominant prey species and, together with garden dormice, made up 14.8–28.5% of prey items in the diet of this owl species (Table 2).



Hazel dormice are comparatively small rodents according to their body mass, but they may be important prey for some owl species in regions where these dormice are abundant. The diet of the tawny owl is well investigated in many countries, and the proportion of the hazel dormouse in the diet of this owl species may reflect the dormouse abundance in particular countries or regions. In many countries where both species are sympatric, the hazel dormouse on average accounted for only 1–2% of all prey items consumed by the tawny owl, e.g., in the Czech Republic [37], France [82], Hungary [83] and Lithuania [84]. Meanwhile, in Slovakia, 3975 hazel dormice recorded in the diet of this owl species accounted for 5.84% of all prey items, including invertebrates, and in some habitats or localities, this proportion was even 8.8–16.2% [37,55]. According to this index, Slovakia is expected to have one of the highest abundances of the hazel dormouse in the entire range. A slightly lower abundance of the hazel dormouse could be found in Italy. According to the summary of studies on the diet of the tawny owl in 14 localities of northern and central Italy, the proportion of the hazel dormouse was 4.5%, including invertebrates [36]. A relatively high proportion of the hazel dormouse in the diet of the tawny owl (8.65%) was recorded in Romania [37]. However, these data do not represent the entire country, because the largest sample of this owl's pellets was collected in the Apuseni Mountains. In two localities of Serbia, the proportion of the hazel dormouse exceeded 10% among all vertebrates caught by the tawny owl [57].

The boreal owl is another owl species that may have a considerable influence on the hazel dormouse. According to Obuch [37], the hazel dormouse accounted for 11.5% of all prey items of the boreal owl in Slovakia. The hazel dormouse made up 11.4–17.5% of prey items of the boreal owl in some localities of Germany, the Czech Republic, Serbia, Belarus and Ukraine (Table 2). Mráz [68] found as many as 14 hazel dormice among 23 small mammals (i.e., 60.9%) in one nestbox of the boreal owl in southern Bohemia. In the present study, we found that the proportion of the hazel dormouse did not exceed 5% in the diets of the remaining owl species.

According to our study, dormice are usually only accidental prey in the diets of diurnal birds of prey. However, in the diet of the golden eagle in the Italian Alps, 25 individuals of the edible dormouse and four individuals of the hazel dormouse were found among food remains collected in eagle nests, and they formed 11.7% of total prey items [71]. In Provence, France, edible dormice made up 10.5% of prey items in the diet of the golden eagle [72].

Arboreal dormice seldom form more than 10% of prey items in the total diets of mammalian predators. Italy stands out in this respect, where dormice exceeded this proportion in the diets of small predators such as the European wild cat, beech marten, pine marten and stoat *Mustela erminea* (Table 2). There is a noteworthy comparatively high proportion of the garden dormouse in the diet of the pine marten and the stoat in Italy [77–79]. Dormice were found in the diet of the red fox, but only in 2 out of 24 cases did their proportion reach 10% [38,80]. Dormice may be important prey for mammalian predators in particular seasons. In north-western Italy, the edible dormouse was an important food for the pine marten in autumn and winter [75], and the garden dormouse was important in the diet of the pine marten in Minorca Island in spring [78].

In the northern Dinaric Mountains (Slovenia and Croatia), the Eurasian lynx also frequently fed on edible dormice (18% frequency of occurrence and 7% of all consumed biomass). Edible dormice appear to be an important alternative prey, especially for adult females and juveniles. The remains of edible dormice were found in 50% of the stomachs of adult females and in 27% of juveniles, but never in adult males. The edible dormouse was used by lynx more frequently in years with higher availability [25].

In regions where dormice are rare, their role in the diets of predators is negligible. However, in such areas, predators catching even single females before or during the breeding season may have a significant influence on reproduction success in small dormouse populations [85]. In the study by Verbeylen et al. [86], out of 19 successfully overwintered radio-tagged hazel dormice, 6 individuals (31.6%) were caught by predators in spring after hibernation. In Lithuania, four aluminium rings used to mark hazel dormice were found

amongst food remains left by tawny owls in one nestbox in spring, and the dormouse density decreased considerably in the area of the study site where owls had hunted [87]. Polish researchers estimated that tawny owls could remove from 604 to 1041 individuals of hazel dormice in the study area (60 km<sup>2</sup>) every year, i.e., 10.1–17.4 individuals per km<sup>2</sup> [88]. Predation by tawny owls and other predators may be the main reason for the high spring and summer mortality of hazel dormouse populations [85,86,88]. As a consequence, together with other unfavourable extrinsic and intrinsic factors, predators can cause a decrease in dormouse abundance, which can even result in the extinction of small local dormouse populations [46,89,90].

### 3.4. Dormice in Winter Diets of Predators

It was previously supposed that predation is an important factor in the high winter mortality of dormice [28,46,91]. However, according to the sources analysed, dormice were seldom recorded in the winter diets of predators: in 53 out of 535 sources containing information on dormice in the diets of predators. In most cases, hazel and edible dormice were found in the winter diets of three owl species and eight mammal species (Table 3).

**Table 3.** Predators in whose diet dormice were recorded in winter period and number of sources containing such information.

Predator Species	Number of Sources				Total Dormice	Total Number of Sources
	<i>Muscardinus avellanarius</i>	<i>Glis glis</i>	<i>Dryomys nitedula</i>	<i>Eliomys quercinus</i>		
Owls						
<i>Tyto alba</i>	9			1	10	100
<i>Strix aluco</i>	1	1	1		3	137
<i>Asio otus</i>	19		1		20	53
Mammals						
<i>Canis aureus</i>	1	1	1		1 *	10
<i>Vulpes vulpes</i>	3	2			5	24
<i>Martes foina</i>		3			3	22
<i>Martes martes</i>		2			2	25
<i>Martes sp.</i>		1			1	2
<i>Felis silvestris</i>		1			1	17
<i>Lynx lynx</i>		1			1	6
<i>Procyon lotor</i>	1				1	2
<i>Sus scrofa</i>	1	1			2	3
Total	37	12	3	1	53	400

\* All three dormouse species were indicated in the same source [92].

Among all European owl species, the long-eared owl accounted for the highest number of cases in which dormice were recorded in its winter diet (20 out of 53 sources): hazel dormice in 19 cases and forest dormice in 1 case. Dormice were also recorded in the winter diet of the barn owl (10 out of 100 sources). In contrast, out of 137 sources containing records on dormice in the diet of the tawny owl, only in three cases were dormice found in their winter diet. In central Poland, even in four unusually warm years, hazel dormice were recorded in the diet of the tawny owl only in the warm season, but not in the cold season [93].

A possible explanation for these differences among owl species is that there are many studies on the winter diet of the long-eared owl as well as the barn owl, but not the tawny owl. During the winter, long-eared owls are found in large flocks that roost in permanent places, where their pellets accumulate, and it is easy to collect them. Similarly, the barn owl is a relatively easy species to study because it uses the same day-roost for a long time and regularly casts one of its two nightly pellets at this roost. In contrast, tawny owls cast all of

their pellets before going to roost. Therefore, their pellet stations are scattered about, often in deep cover, and change irregularly and frequently [37,43,94].

Most records of dormice in the winter diets of owls are from countries of Southern and Central Europe (mostly Italy, less so Slovakia, Bulgaria, Moldova, Poland and Switzerland). Radio-tracking studies of the hazel dormouse carried out in Switzerland, Belgium and Great Britain showed that in winter, during arousals from hibernation, dormice may change their hibernacula [86,95,96]. Thus, dormice could be caught by owls when they moved from one hibernaculum to another during the thaw periods. In Slovakia, pellets of long-eared owls were collected in five-day intervals in winter, and the remains of hazel dormice were recorded during short warmer periods [97,98]. Vogel and Frey [95] did not exclude the possibility that disturbance during the study period led to successive changes in hibernation nests in spite of precautions taken. However, records of dormice in the winter diets of owls confirm that dormice can leave their hibernacula during arousals in thaw periods because owls can catch them only outside their hibernacula.

Among mammalian predators, dormice were most often recorded in the winter diets of the red fox, pine marten and beech marten, but also in five other mammal species (Table 3). If owls can catch only those dormice that are active in winter, mammals can also find hibernating dormice whose hibernacula are situated on the ground surface or underground. During hibernation, dormice reduce their respiration and metabolism, which helps the animals to remain largely odourless and makes them difficult to detect for predators [99]. That explains the low predation rate by mammals that can find hibernating dormice just by chance. Edible dormice use underground hibernation, not primarily to avoid cold environments and the scarcity of food, but to avoid predation by remaining in hibernacula whenever possible [99].

Edible dormice hibernating in caves were preyed upon by lynxes and beech martens in Slovenia and Croatia [25,100]. The remains of edible dormice were found in several scats and the stomachs of lynxes collected during midwinter. Lynxes most likely catch dormice in rock crevices and caves, which are abundant and regularly used by dormice during hibernation [25]. Signs of beech martens were also found deep inside the caves. Dormouse remains in winter scats of beech martens suggest predation upon cave-hibernating edible dormice [100]. The snow tracking of lynxes and beech martens showed that lynxes frequently inspect caves [25], and beech martens can stay in such caves for several days [100].

Radio-tracing studies indicate a high predation rate on hibernating hazel dormice. In the study by Verbeylen et al. [86], 5 out of 18 radio-collared hazel dormice (27.7%) were predated by mammalian predators during hibernation, but the species of the predators were unknown. In the study by Vogel and Frey [95], two out of six free-ranging hazel dormice (33%) marked with radioactive tags and studied during winter in their natural habitat became victims of the red fox and an unknown predator. However, the human influence on increased predation rates cannot be excluded in both studies.

The wild boar was indicated as a predator of hibernating dormice in some publications [28–30,91]. However, dormice were found exceptionally seldom in the diet of the wild boar [30,101,102]. A list of species eaten by the wild boar in Western Europe, including 18 species of mammals, is presented in a review paper by Schley and Roper [103], but dormice are absent in this list, and they are not mentioned at all in another review paper on the diet of the wild boar [104]. Rozycka et al. [29] do not provide any evidence of wild boar predation on dormice, but they found a significant negative correlation between wild boar presence and hazel dormouse population indices. Predation on hazel dormice by the wild boar is most likely to occur during the winter months due to wild boar rooting behaviour whilst dormice are hibernating at ground level. In spite of the scarce direct evidence of its predation on dormice, the wild boar can have a significant impact on dormouse hibernacula because of its rooting activity [29,30,105–107].

The absence of a hibernation period and regular winter activity was recorded in the hazel dormouse in some Mediterranean ecosystems in Italy [108]. This circumstance could explain the highest number of dormouse records in the winter diets of owls in Italy. In the

study by Verbeylen et al. [86], some radio-collared hazel dormice were caught by owls just before hibernation. In such cases, pellets collected in early winter and attributed to the winter season could contain the remains of dormice preyed upon by owls in late autumn just before hibernation. The high winter mortality assessed in some hazel dormouse populations using a simple enumeration method [28,109] may be overestimated because some overwintered dormice may not have been recorded by the researchers, as they could have been caught by predators during the spring [110].

#### 4. Conclusions

This review of publications on dormice in the diets of predators has refuted, clarified or supported some of the previous statements and showed that:

- Dormice may be an important food source for predators in some regions, especially in autumn;
- Mammalian predators are not a significant factor in dormouse winter mortality;
- Dormice may leave their hibernacula in the winter period;
- Nocturnal dormice may also be active in the daytime.

This review also showed a very uneven level of examination of the diets of predators in individual countries. This circumstance could determine the relatively low number of predator species of the forest dormouse found in this review. The comparatively low occurrence of dormice in the winter diets of predators indicates that predators are not the main factor in the high winter mortality of dormice, and this question needs further research.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/d15010052/s1>, List of references to sources containing information on dormice in the diets of predators in Europe.

**Funding:** This research was performed as part of a long-term research program of the Nature Research Centre with no external funding.

**Data Availability Statement:** A list of references to sources containing information on dormice in the diets of predators in Europe is presented in Supplementary Materials.

**Acknowledgments:** The author is grateful to Sven Büchner, Johannes Lang, Anna Marchewka, Filip Tulis and Goedele Verbeylen, who provided information on dormice in the diets of predators, and to Vitalijus Stirkė for photos of animals for the graphical abstract.

**Conflicts of Interest:** The author declares no conflict of interest.

#### References

1. Holden-Musser, M.E.; Juškaitis, R.; Musser, G.M. Family Gliridae (Dormice). In *Handbook of the Mammals of the World. Lagomorphs and Rodents I*; Wilson, D.E., Lacher, T.E., Jr., Mittermeier, R.A., Eds.; Lynx Edicions: Barcelona, Spain, 2016; Volume 6, pp. 838–889.
2. Airapetyants, A.E. *Dormice*; Leningrad University Press: Leningrad, Russia, 1983; 192p. (In Russian)
3. Rossolimo, O.L.; Potapova, E.G.; Pavlinov, I.Y.; Kruskop, S.V.; Voltzit, O.V. *Dormice (Myoxidae) of the World*; Moscow University Press: Moscow, Russia, 2001; 229p. (In Russian)
4. IUCN. The IUCN Red List of Threatened Species. 2022. Available online: <http://www.iucnredlist.org/> (accessed on 15 November 2022).
5. Kryštufek, B. *Glis glis* (Rodentia: Gliridae). *Mamm. Species* **2010**, *42*, 195–206. [CrossRef]
6. Juškaitis, R. *The Common Dormouse Muscardinus avellanarius: Ecology, Population Structure and Dynamics*, 2nd ed.; Nature Research Centre Publishers: Vilnius, Lithuania, 2014; 196p.
7. Morris, P. *Dormice: A Tail of Two Species*, 2nd ed.; Whittet Books: Stansted, UK, 2011; 144p.
8. Montecchio, L.; Scattolin, L.; De Battisti, R. Dormouse injuries predispose beech to infection by *Neonectria ditissima*. *For. Pathol.* **2011**, *41*, 114–119. [CrossRef]
9. Büchner, S.; Trout, R.; Adamík, P. Conflicts with *Glis glis* and *Eliomys quercinus* in households: A practical guideline for sufferers (Rodentia: Gliridae). *Lynx* **2018**, *49*, 19–26. [CrossRef]
10. Andreychev, A. Distribution and population density forest dormouse (*Dryomys nitedula*, Rodentia, Gliridae) in a region of the Middle Volga, Russia. *Ecol. Environ. Conserv.* **2021**, *27*, 369–373.
11. Carpaneto, G.M.; Cristaldi, M. Dormice and man: A review of past and present relations. *Hystrix* **1994**, *6*, 303–330.
12. Juškaitis, R. Interactions between dormice (Gliridae) and hole-nesting birds in nestboxes. *Folia Zool.* **2006**, *55*, 225–236.

13. Adamík, P.; Král, M. Nest losses of cavity nesting birds caused by dormice (Gliridae, Rodentia). *Acta Theriol.* **2008**, *53*, 185–192. [CrossRef]
14. Czeszczewik, D.; Walankiewicz, W.; Stanska, M. Small mammals in nests of cavity-nesting birds: Why should ornithologists study rodents? *Can. J. Zool.* **2008**, *86*, 286–293. [CrossRef]
15. Kuipers, L.; Scholten, J.; Thissen, J.B.M.; Bekkers, L.; Geertsma, M.; Pulles, R.; Siepel, H.; van Turnhout, L. The diet of the garden dormouse (*Eliomys quercinus*) in the Netherlands in summer and autumn. *Lutra* **2012**, *55*, 17–27.
16. Juškaitis, R.; Baltrūnaitė, L. Feeding on the edge: The diet of the hazel dormouse *Muscardinus avellanarius* (Linnaeus 1758) on the northern periphery of its distributional range. *Mammalia* **2013**, *77*, 149–155. [CrossRef]
17. Juškaitis, R.; Baltrūnaitė, L. Seasonal variability in the diet of the forest dormouse, *Dryomys nitedula*, on the north-western edge of its distributional range. *Folia Zool.* **2013**, *62*, 311–318. [CrossRef]
18. Juškaitis, R.; Baltrūnaitė, L.; Augutė, V. Diet of the fat dormouse (*Glis glis*) on the northern periphery of its distributional range. *Mammal Res.* **2015**, *60*, 155–161. [CrossRef]
19. Vekhnik, V.A. Nutrition of the edible dormouse (*Glis glis* Linnaeus, 1766) across the distributional range. *J. Wildl. Biodivers.* **2022**, *6*, 1–23.
20. Jentzsch, M. Zur Verbreitung der Haselmaus (*Muscardinus avellanarius* Linnaeus, 1758) in Sachsen-Anhalt. *Herzynia N. F.* **2004**, *37*, 127–135.
21. Nedyalkov, N.; Popgeorgiev, G.; Staneva, A. Updated distribution of the elusive Roach’s mouse-tailed dormouse, *Myomimus roachi* Bate, 1937 (Mammalia: Rodentia: Gliridae) in Bulgaria. *Hist. Nat. Bulg.* **2018**, *29*, 3–8. [CrossRef]
22. Bertolino, S. Distribution and status of the declining garden dormouse *Eliomys quercinus*. *Mammal Rev.* **2017**, *47*, 133–147. [CrossRef]
23. Fedyń, I.; Figarski, T.; Kajtoch, Ł. Overview of the impact of forest habitats quality and landscape disturbances on the ecology and conservation of dormice species. *Eur. J. For. Res.* **2021**, *140*, 511–526. [CrossRef]
24. Marchesi, L.; Sergio, F.; Pedrini, P. Implications of temporal changes in forest dynamics on density, nest-site selection, diet and productivity of tawny owls *Strix aluco* in the Alps. *Bird Study* **2006**, *53*, 310–318. [CrossRef]
25. Krofel, M.; Huber, D.; Kos, I. Diet of Eurasian lynx *Lynx lynx* in the northern Dinaric Mountains (Slovenia and Croatia): Importance of edible dormouse *Glis glis* as alternative prey. *Acta Theriol.* **2011**, *56*, 315–322. [CrossRef]
26. Vrezec, A.; Mihelič, D. The Ural owl, *Strix uralensis macroura*, in Slovenia: An overview of current knowledge on species ecology. *Riv. Ital. Ornitol.* **2013**, *82*, 30–37. [CrossRef]
27. Rajković, D.Z. Diet composition and prey diversity of Tengmalm’s owl *Aegolius funereus* (Linnaeus, 1758; Aves: Strigidae) in central Serbia during breeding. *Turk. J. Zool.* **2018**, *42*, 346–351.
28. Juškaitis, R. Winter mortality of the common dormouse (*Muscardinus avellanarius*) in Lithuania. *Folia Zool.* **1999**, *48*, 11–16.
29. Rozycka, D.; Lim, J.M.; Trout, R.C.; Brooks, S. Have feral boar significantly impacted hazel dormouse populations in Sussex, England? *Folia Zool.* **2015**, *64*, 337–341. [CrossRef]
30. Scaravelli, D.; Aloise, G. Predation on dormice in Italy. *Hystrix* **1994**, *6*, 245–255.
31. März, R. Nachweise von Schläfern aus Gewöllen. *Beitr. Vogelkunde* **1963**, *8*, 388–396.
32. Obuch, J. Dormice in the diet of owls in Slovakia. *Lynx* **1998**, *29*, 31–41, (In Slovak with English Summary).
33. Obuch, J. Dormice in the diet of owls in the Middle East. *Trak. Univ. J. Sci. Res.* **2001**, *2*, 145–150.
34. Moreno, S. Lirón careto–*Eliomys quercinus*. In *Enciclopedia Virtual de los Vertebrados Españoles*; Salvador, A., Barja, I., Eds.; Museo Nacional de Ciencias Naturales: Madrid, Spain, 2017. Available online: <http://www.vertebradosibericos.org/> (accessed on 15 November 2022).
35. Janossy, D.; Schmidt, E. Die Nahrung des Uhus (*Bubo bubo*). Regionale und erdzeitliche Änderungen. *Bonn. Zool. Beitr.* **1970**, *21*, 25–51.
36. Capizzi, D. Diet shifts of the tawny owl *Strix aluco* in central and northern Italy. *Ital. J. Zool.* **2000**, *67*, 73–79. [CrossRef]
37. Obuch, J. Spatial and temporal diversity of the diet of the tawny owl (*Strix aluco*). *Slovak Raptor J.* **2011**, *5*, 1–120. [CrossRef]
38. Donaurov, S.S.; Popov, V.C.; Khonjakina, Z.P. The dormouse (*Glis glis caspicus* (Sat.) in the Caucasian reservation territory. *Proc. Cauc. State Reserve* **1938**, *1*, 227–280, (In Russian with English Summary).
39. Ognev, S.I. *Mammals of the USSR and Adjacent Countries. Rodents*; Academy of Science of the USSR Press: Moscow–Leningrad, Russia, 1947; Volume 5, 809p. (In Russian)
40. Lozan, M.; Belik, L.; Samarskij, S. *Dormice (Gliridae) of the South-West USSR*; Shtiintsa: Kishinev, Moldova, 1990; 147p. (In Russian)
41. Hanski, I.P.; Henttonen, H. Garden Dormouse Disappeared from Finland? *Luomus*. 2014. Available online: <https://www.luomus.fi/en/garden-dormouse-disappeared-finland> (accessed on 15 November 2022).
42. Uttendörfer, O. *Die Ernährung der deutschen Raubvögel und Eulen und ihre Bedeutung in der heimischen Natur*, 2 Aufl.; Aula Verlag: Wiesbaden, Germany, 1997; 412p.
43. Pukinskij, J.B. *The Life of Owls*; Leningrad University Press: Leningrad, Russia, 1977; 240p. (In Russian)
44. Galeotti, P. *Strix aluco* Tawny Owl. In *Birds of Western Palearctic, Update 3*; Oxford University Press: Oxford, UK, 2001; pp. 43–77.
45. Glue, D.E. Food of the barn owl in Britain and Ireland. *Bird Study* **1997**, *21*, 200–210. [CrossRef]
46. Bright, P.W.; Morris, P.A. Why are dormice rare? A case study in conservation biology. *Mammal Rev.* **1996**, *26*, 157–187. [CrossRef]
47. Andreychev, A.V.; Lapshin, A.S.; Kuznetsov, V.A. Food spectrum of the eagle owl (*Bubo bubo*) in the Republic of Mordovia. *Zool. Zhurnal* **2014**, *93*, 248–258.

48. Capizzi, D.; Luiselli, L. The diet of the four-lined snake (*Elaphe quatuorlineata*) in mediterranean central Italy. *Herpetol. J.* **1997**, *7*, 1–5.
49. Kryštufek, B.; Hudoklin, A.; Pavlin, D. Population biology of the edible dormouse *Glis glis* in mixed montane forest in central Slovenia over three years. *Acta Zool. Hung.* **2003**, *49* (Suppl. 1), 85–97.
50. Manganaro, A.; Ranazzi, L.; Salvati, L. The diet of Tawny Owls (*Strix aluco*) breeding in different woodlands of Central Italy. *Buteo* **2000**, *11*, 115–124.
51. Sergio, F.; Marchesi, L.; Pedrini, P.; Peneteriani, V. Coexistence of a generalist owl with its intraguild predator: Distance-sensitive or habitat-mediated avoidance? *Anim. Behav.* **2007**, *74*, 1607–1616. [[CrossRef](#)]
52. Sarà, M.; Zanca, L. The feeding habits of the tawny owl *Strix aluco* in Sicily and in Aspromonte (Calabria). *Avocetta* **1989**, *13*, 31–39, (In Italian with English Summary).
53. Kuhar, B.; Kalan, G.; Janžekovič, F. Diet of the Tawny Owl *Strix aluco* in the Kozjansko region (E Slovenia). *Acrocephalus* **2006**, *27*, 147–154, (In Slovenian with English Summary).
54. Demianchuk, V. Long-term dynamics of wood species of Micromammalia on the Vygonoshchi wood-marsh file. *Sci. J. Lesya Ukr. Volyn Natl. Univ.* **2009**, *2*, 234–238, (In Russian with English Summary).
55. Poláček, M.; Baláž, M.; Obuch, J. Diet of the tawny owl (*Strix aluco*) in urban and forest environment. *Tichodroma* **2012**, *24*, 29–39, (In Slovak with English Summary).
56. Obuch, J.; Benda, P. Contribution to the feeding ecology of *Strix aluco* and *Bubo bubo* (Aves: Strigiformes) in southwestern Bulgaria. *Acta Soc. Zool. Bohem.* **1996**, *60*, 43–49.
57. Jovanovic-Grove, T.; Šćiban, M.; Ružić, M. Study of Tawny Owl *Strix aluco* Diet from Pellet Samples Collected in Serbia. The Owl Pages. 2008. Available online: <https://www.owlpages.com/owls/articles.php?a=58> (accessed on 15 November 2022).
58. Vavylis, D. Diet Analysis of Three Owl Species *Tyto alba*, *Strix aluco* and *Asio otus*. Bachelor's Thesis, Aristotle University of Thessaloniki, Thessaloniki, Greece, 2012. (In Greece).
59. Turini, R. Preliminary data on the micromammals of the “Orrrido di Botri Natural Reserve” from Tawny Owl pellets and fox and weasel scat analysis. *Atti della Societa Toscana di Scienze Naturali Mem. Ser. B* **1994**, *101*, 101–105, (In Italian with English Summary).
60. Vrezec, A. The ecology of the Ural Owl at south-western border of its distribution (Slovenia). *Raptors Conserv.* **2016**, *32*, 8–20. [[CrossRef](#)]
61. Marchesi, L.; Sergio, F.; Pedrini, P. Costs and benefits of breeding in human-altered landscapes for the eagle owl *Bubo bubo*. *Ibis* **2002**, *144*, 164–177. [[CrossRef](#)]
62. Marchesi, L.; Pedrini, P.; Sergio, F. Biases associated with diet study methods in the Eagle Owl. *J. Raptor Res.* **2002**, *36*, 11–16.
63. Bayle, P. Régime alimentaire du grand-duc d'Europe *Bubo bubo* en période de reproduction dans le Parc National du Mercantour et ses environs Alpes-Maritimes et Alpes-de-Haute-Provence, France. *Avocetta* **1996**, *201*, 12–25.
64. Rathgeber, C.; Bayle, P. Régime alimentaire du grand duc d'Europe, *Bubo bubo*, en période de reproduction, dans la région de menton (Alpes-Maritimes, France). *Avocetta* **1997**, *20*, 12–25.
65. Lipej, L.; Kryštufek, B. Dormice as prey of owls: Evidence from Slovenia. In *Abstract Book, Proceedings of the IVth International Conference on Dormice (Rodentia, Gliridae), Edirne, Turkey, 13–16 September 1999*; Trakya University Press: Edirne, Turkey, 1999; p. 26.
66. Klaas, C. Zur Verbreitung des Rauhfußkauzes. *Nat. und Mus.* **1971**, *101*, 467–471.
67. Kloubec, B.; Vacík, R. Outline of food ecology of Tengmalm's owl (*Aegolius funereus* L.) in Czechoslovakia. *Tichodroma* **1990**, *3*, 103–125, (In Czech with English Summary).
68. Mráz, L. Small mammals in the food of owls on the territory of south Bohemia. *Lynx* **1987**, *23*, 63–74, (In Czech with English Summary).
69. Kitel', D.A. Peculiarities of Breeding of Some Owl Species in the Brest Oblast'. Master's Thesis, Pushkin University, Brest, Belarus, 2010. (In Russian)
70. Kuzmenko, Y.; Mishta, A. Diet of Tengmalm's owl (*Aegolius funereus*) and great grey owl (*Strix nebulosa*) in northern Ukraine. *Proc. Zool. Mus.* **2014**, *45*, 65–69, (In Ukrainian with English and Russian Summaries).
71. Pedrini, P.; Sergio, F. Density, productivity, diet, and human persecution of golden eagles (*Aquila chrysaetos*) in the central-eastern Italian Alps. *J. Raptor Res.* **2001**, *35*, 40–48.
72. Iborra, O.; Arthur, C.; Bayle, P. Importance trophique du lapin de garenne pour les grands rapaces provençaux. *Vie et Milieu* **1990**, *40*, 177–188.
73. Apostolico, F.; Vercillo, F.; La Porta, G.; Ragni, B. Long-term changes in diet and trophic niche of the European wildcat (*Felis silvestris silvestris*) in Italy. *Mammal Res.* **2016**, *61*, 109–119. [[CrossRef](#)]
74. Balestrieri, A.; Mosini, A.; Saino, N. *Distribuzione ed Ecologia di Martora e Faina nel Parco Nazionale della Val Grande 2015–2016*; Technical Report; University of Milan: Milan, Italy, 2016; 47p.
75. Bertolino, S.; Dore, B. Food habits of the stone marten *Martes foina* in “La Mandria” Regional Park (Piedmont region, north-western Italy). *Hystrix* **1995**, *7*, 105–111.
76. Genovesi, P.; Secchi, M.; Boitani, L. Diet of stone martens: An example of ecological flexibility. *J. Zool.* **1996**, *238*, 545–555. [[CrossRef](#)]
77. Lombardini, M.; Murru, M.; Repossi, A.; Cinerari, C.E.; Vidus Rosin, A.; Mazzoleni, L.; Meriggi, A. Spring diet of the pine marten in Sardinia, Italy. *Anim. Biodivers. Conserv.* **2015**, *38*, 183–190. [[CrossRef](#)]
78. Clevenger, A.P. Spring and summer food habits and habitat use of the European pine marten (*Martes martes*) on the island of Minorca, Spain. *J. Zool.* **1993**, *229*, 153–161. [[CrossRef](#)]

79. Martinoli, A.; Preatoni, D.G.; Chiarenzi, B.; Wauters, L.A.; Tosi, G. Diet of stoats (*Mustela erminea*) in an Alpine habitat: The importance of fruit consumption in summer. *Acta Oecol.* **2001**, *22*, 45–53. [\[CrossRef\]](#)
80. Storch, I.; Kleine, C. Zur Nahrungswahl des Fuchses in den Voralpen. *Z. Jagdwiss.* **1991**, *37*, 267–270. [\[CrossRef\]](#)
81. Milchev, B.; Georgiev, V. Food spectrum and predominant prey in the diet of the eagle owl *Bubo bubo* population in Southeastern Bulgaria. *For. Ideas* **2019**, *25*, 56–69.
82. Baudvin, H.; Jouaire, S. Le régime alimentaire d'une population forestière de Chouettes hulottes (*Strix aluco*) en Bourgogne. *Rev. Sci. Bourgogne-Nat.* **2006**, *4*, 85–89.
83. Hecker, K.; Bakó, B.; Csorba, G. New data on the distribution of the Hungarian dormouse species (Gliridae). *Állattani Közlemények* **2003**, *88*, 57–67, (In Hungarian with English Summary).
84. Balčiauskienė, L.; Balčiauskas, L. Common dormouse as a prey item of breeding tawny owls in five districts of Lithuania. *Acta Zool. Lituan.* **2008**, *18*, 58–62. [\[CrossRef\]](#)
85. Juškaitis, R. Summer mortality in the hazel dormouse (*Muscardinus avellanarius*) and its effect on population dynamics. *Acta Theriol.* **2014**, *59*, 311–316. [\[CrossRef\]](#)
86. Verbeylen, G.; Andre, A.; Desmet, A.; Manzanares, L.; Mels, B.; Pulles, R.; Swinnen, K.; Vanseuninghen, I.; Vermeiren, M. *et al.* *Nest Site Selection and Use of Other Habitats by the Hazel Dormouse Muscardinus Avellanarius in Voeren (Flanders)*; Report Natuurpunt studie 2017/3; Natuurpunt Research Department (Mammal Working Group): Mechelen, Belgium, 2017; 851p.
87. Juškaitis, R. Local impact of the tawny owls (*Strix aluco*) on the common dormice (*Muscardinus avellanarius*) in Lithuania. *Ekologija* **2004**, *23*, 305–309.
88. Żmihorski, M.; Gryz, J.; Krauze-Gryz, D.; Olczyk, A.; Osojca, G. The tawny owl *Strix aluco* as a material collector in faunistic investigations: The case study of small mammals in NE Poland. *Acta Zool. Lituan.* **2011**, *21*, 185–191. [\[CrossRef\]](#)
89. Iannarilli, F.; Melcore, I.; Sozio, G.; Roviani, D.; Mortelliti, A. Long-term colonization and extinction patterns of a forest-dependent rodent (*Muscardinus avellanarius*) in highly fragmented landscapes. *Hystrix* **2017**, *28*, 73–77.
90. Juškaitis, R. Forest dormouse *Dryomys nitedula* (Pallas, 1778). In *Red Data Book of Lithuania. Animals, Plants, Fungi*; Rašomavičius, V., Ed.; Lututė: Vilnius, Lithuania, 2021; 300p, (In Lithuanian with English Summary).
91. Goethe, F. Die Säugetiere des Teutoburger Waldes und des Lipperlandes. *Abh. Landesmus. Nat. Münster Westfal.* **1955**, *17*, 5–195.
92. Čirović, D.; Penezić, A.; Milenković, M.; Paunović, M. Winter diet composition of the golden jackal (*Canis aureus* L., 1758) in Serbia. *Mamm. Biol.* **2014**, *79*, 132–137. [\[CrossRef\]](#)
93. Romanowski, J.; Żmihorski, M. Seasonal and habitat variation in the diet of the tawny owl (*Strix aluco*) in Central Poland during unusually warm years. *Biologia* **2009**, *64*, 365–369. [\[CrossRef\]](#)
94. Southern, H.N. Tawny owls and their prey. *Ibis* **1954**, *96*, 384–410. [\[CrossRef\]](#)
95. Vogel, P.; Frey, H. L'hibernation du muscardin *Muscardinus avellanarius* (Gliridae, Rodentia) en nature: Nids, fréquence des reveils et température corporelle. *Bull. Soc. Vaudoise Sci. Nat.* **1995**, *83*, 217–230.
96. Gubert, L.; McDonald, R.A.; Wilson, R.J.; Chanin, P.; Bennie, J.J.; Mathews, F. The elusive winter engineers: Structure and materials of hazel dormouse hibernation nests. *J. Zool.* **2022**, *316*, 81–91. [\[CrossRef\]](#)
97. Tulis, F. The Influence of Land Use to Diet of Long-Eared Owl (*Asio otus*). Ph.D. Thesis, Constantine the Philosopher University, Nitra, Slovakia, 2013. (In Slovakian with English Summary).
98. Tulis, F.; Constantine the Philosopher University, Nitra, Slovakia. Personal communication, 2022.
99. Ruf, T.; Bieber, C. Why hibernate? Predator avoidance in the edible dormouse. *Mammal Res.* **2022**. [\[CrossRef\]](#)
100. Polak, S. The use of caves by the edible dormouse (*Myoxus glis*) in the Slovenian karst. *Nat. Croat.* **1997**, *6*, 313–321.
101. Vietinghoff-Riesch, A. *Der Siebenschläfer (Glis glis L.)*; VEB Gustav Fischer Verlag: Jena, Germany, 1960; 196p.
102. Drenik, K. Diet of Wild Boar (*Sus scrofa*) in Kočevje Region. Master's Thesis, University of Ljubljana, Slovenia, 2007. (In Slovenian with English Summary).
103. Schley, L.; Roper, T.J. Diet of wild boar *Sus scrofa* in Western Europe, with particular reference to consumption of agricultural crops. *Mammal. Rev.* **2003**, *33*, 43–56. [\[CrossRef\]](#)
104. Ballari, S.A.; Barrios-García, M.N. A review of wild boar *Sus scrofa* diet. *Mammal Rev.* **2014**, *44*, 124–134. [\[CrossRef\]](#)
105. Singer, F.J.; Swank, W.T.; Clebsh, E.E.C. Effects of wild pig rooting in a deciduous forest. *J. Wildlife Manag.* **1984**, *48*, 464–473. [\[CrossRef\]](#)
106. Mori, E.; Ferretti, F.; Lagrotteria, A.; La Greca, L.; Solano, E.; Fattorini, N. Impact of wild boar rooting on small forest-dwelling rodents. *Ecol. Res.* **2020**, *35*, 675–681. [\[CrossRef\]](#)
107. Büchner, S.; Büro für ökologische Studien, Markersdorf, Germany. Personal communication, 2022.
108. Panchetti, F.; Amori, G.; Carpaneto, G.M.; Sorace, A. Activity patterns of the common dormouse (*Muscardinus avellanarius*) in different Mediterranean ecosystems. *J. Zool.* **2004**, *262*, 289–294. [\[CrossRef\]](#)

109. Likhachev, G.N. Population structure of the common dormouse (*Muscardinus avellanarius*). *Byull. Moskovsk. Obshch. Isp. Prir. Otd. Biol.* **1966**, *71*, 18–29, (In Russian with English Summary).
110. Bieber, C.; Juškaitis, R.; Turbill, C.; Ruf, T. High survival during hibernation affects onset and timing of reproduction. *Oecologia* **2012**, *169*, 155–166. [[CrossRef](#)]

**Disclaimer/Publisher’s Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.