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Distribution and Ecology of the Morels and False Morels of Iowa

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The distribution, time of fruiting and habitats of morels and false morels in Iowa were documented during a 10 year survey (1984–1993). Distribution maps for each species also include information from published reports and from herbarium records. The true morel genus, *Morchella,* is represented in Iowa by five species. Three of these species, *M. deliciosa,* M. esculenta and *M. crassipes,* are sometimes interpreted as segments of one large, extremely variable species. *M. semilibera* and *M. angusticeps* also occur. *M. angusticeps,* a black morel, has not been previously reported from Iowa. Four false morels, two species in each of two genera, *Verpa conica, Verpa bohemica, Gyromitra brunnea, Gyromitra caroliniana,* also develop in the spring during morel season. One species of *Gyromitra, G. infula,* a fall species known in Iowa only from a single collection in Johnson County in Sept 1926 by G.W. Martin, is not included in this paper. The earliest date of collection was *Verpa bohemica* on 1 April, the latest was *Morchella esculenta* on 10 June. However, the average first collection date for any species was 12 April and the average latest date was 22 May. Distribution in Iowa was quite limited for some species of morels and false morels. Habitats were not uniquely different for any species, but distinctive associations were reported to be common for some species.

INDEX DESCRIPTORS: morels, sponge mushrooms, false morels, *Morchella, Verpa, Gyromitra.*

The fungi known commonly as morels and false morels are large, stalked, fleshy fungi of the order Pezizales in the Discomycete group of the Ascomycetes (Dennis 1981). Asci and sterile hyphae (paraphyses) develop in a layer on the distinctive upper portion of the stalked fruiting body. The order is characterized by asci that are cylindrical, open by a lid (operculum) and contain a single row of eight, one-celled, round to elliptical, usually hyaline, ascospores. When the operculum opens and the mature ascospores are violently released from the ascus, they are dispersed by the wind or may fall out on a nearby surface as a cream to light yellow deposit. The color of the apical area of the fruiting body is due to pigments developed in the paraphyses.

While their vegetative portion (mycelium) is perennial in soil and litter, usually in forest habitats (Volk 1991), morels and false morels typically develop during a limited season, in Iowa for four to five weeks in mid-April to mid-May. The true morel genus, *Morchella,* has species with strongly ridge-pitted apical areas that are fused in at least the terminal portion to the hollow stalk. Three groups of *Morchella* species are often recognized (Bunyard et al. 1994): 1) a group with cylindrical gray or tan to yellowish ridge pitted areas fused with the hollow stalk throughout their length includes *Morchella deliciosa* Fr., *Morchella esculenta* L. and *Morchella crassipes* Vent., 2) a group of black morels with tapered dark grey to black apical regions characterized by black ridges and also fused to the hollow stalks includes *M. elata* Fr., *M. angusticeps* Pk. and *M. conica* Fr., and 3) *M. semilibera* DC with a smaller apical portion that is fused with the hollow stalk for the upper one-third to one-half but is completely free from the stalk below.

Species of *Verpa,* one genus of false morels, are quite similar in size and color to the true morels. However, the apical portion is attached only at the top of the cylindrical stalk and is smooth or longitudinally furrowed. Also the stalks are filled with mycelium giving them a white fuzzy, stuffed appearance easily observed when the stalks are split longitudinally.

Species of the other false morel genus, *Gyromitra,* are quite different. The apical portions are brown to deep reddish-brown, varying from saddle shaped with extra rounded ridges in some species to uniformly brain-like with rounded convolutions in other species. The stalks are heavier, often chambered and sometimes fluted or furrowed.

The species of *Morchella,* commonly known as sponge mushrooms or morels, have long been known as excellently edible fleshy fungi. They occur in the spring when few other fleshy fungi are present, usually in wooded areas, are unique and easily recognized. Searching for them in an Iowa woods during the short season of four to five weeks in late April to early May has long been a challenge to dedicated morel hunters.

During the 1970s, many American elms died of elm wilt and for several years following the death of individual elms, large fruitings of morels occurred under and in the close vicinity of the dead elms. The unusual ease of finding morels and the abundant harvest introduced many people to morel hunting and generated many questions about morels. How early did they occur, and when should one be in the woods looking for them? How long was their season? How many kinds of morels occur in Iowa? Were there other fungi that could be confused with them? Were they really safe to eat? Where should one look for them? How can one find them?

The experienced hunters had field hints that guided their search, an interesting folklore, but there was little published information about morels in Iowa. Seaver (1910), Martin (1960), Gilman (1942) and Jensen (1977) had presented some general information based on their own field observations and information gleaned from their discussions with collectors, but no one had attempted to obtain the field data necessary to provide specific answers to questions of distribution, time of fruiting, and habitat.

Table 1. Collection totals for morels for each year 1984–1995.

	M. esc.[a]	*M. del.*[b]	*M. cra.*[c]	*M. semi.*[d]	*M. ang.*[e]	Total
1984	25	20	5	38	5	93
1985	21	6	8	4	0	39
1986	54	28	14	30	1	127
1987	19	11	2	8	2	42
1988	10	3	1	4	1	19
1989	28	22	5	17	2	74
1990	25	12	18	7	0	62
1991	33	19	5	32	1	90
1992	9	10	3	53	0	75
1993	8	11	2	22	0	43
1994	8	5	2	5	0	20
1995	3	4	1	1	0	9
Total	243	151	66	221	12	693

[a]*M. esc. - Morchella esculenta*
[b]*M. del. - Morchella deliciosa*
[c]*M. cra. - Morchella crassipes*
[d]*M. semi. - Morchella semilibera*
[e]*M. ang. - Morchella angusticeps*

In 1983 the authors and the newly organized Prairie States Mushroom Club began planning a one-year survey of morels and false morels in Iowa. With much help from the extension plant pathologist, Robert Nyvall, the program began in the spring of 1984. From that one-year program the ten-year survey study developed. The specific questions addressed during the survey were: 1) Dates of fruiting—when do morels and false morels develop in the field, 2) the species of morels and false morels that occur in Iowa, 3) the distribution of each species in the state, and 4) the kind of habitats in which they develop. Interesting miscellaneous field information was also recorded.

METHODS

In the first survey year, 1984, the Prairie States Mushroom Club hosted four field collection workshops in different areas of the state to present information about the survey, about morels and false morels, to have general discussions about collecting methods and recording of useful field site information and to collect. In addition, specimens of morels and false morels were requested from morel hunters through information about the survey distributed by extension plant pathologists Robert Nyvall and Laura Sweets, and later Mark Gleason, through the Iowa State University Extension Service. Collectors were encouraged to submit material of morels and false morels through their county extension office or directly to the authors.

Collectors were asked to submit a specimen of each kind of morel or false morel that they had collected, as soon as possible after collection, accompanied by the following information: collector's name, date of collection, county where collected, any information about plants of the collection area and a brief description of the collection area (north hillside, river bottom area, etc.) Response to the last two items varied greatly in detail.

Each collection was given an accession number, photographed, and accompanying information recorded on permanent data sheets In the laboratory each specimen was examined, measured, macroscopic and microscopic information recorded. Spore prints were made if mature ascospores were present. Dried specimens were deposited in the mycology section of the Ada Hayden Herbarium, Department of Botany, Iowa State University. All collections were acknowledged by letter, identifications reported and any questions answered.

After preliminary examination of the 1984 data it was apparent that the survey would need to be continued for a longer period of time to provide significant information and to accommodate the variation in seasons. The members of the Prairie State Mushroom Club continued individually to participate in the survey. The extension plant pathology office and the Iowa State University Extension Service continued to support the project. Interviews and announcements on radio and television at the beginning of morel season each year alerted collectors to the continuing survey and our request for specimens and information. Feature stories were developed in newspapers and in the Department of Natural Resources publication, *The Iowa Conservationist.* (Tiffany and Knaphus 1984; Knaphus, Tiffany and Huffman 1986; Knaphus, Tiffany and Huffman 1990; Knaphus, Tiffany and Huffman 1994).

Even though the survey was not formally continued in 1994 and 1995, collections were contributed and are included in the survey report. Also included is information from published reports and from specimens available in the Ada Hayden herbarium at Iowa State University that had been collected prior to the survey years.

RESULTS

During the 10 year survey, 1984 through 1993, 1019 collections of morels and false morels were examined and recorded (Table 1, Table 2). Forty-six collections that were received in spring, 1994 and 1995 were also included. Some of these volunteered collections were unusual and some were from counties not represented during the survey years. The unusual collections will be commented on under the appropriate species discussions. Distributions are presented on the species maps. Many of the collections consisted of more than one specimen; some had as many as twenty individual fungi. An estimated 2000 individual fungi were examined from 1984 to 1995.

The species of the three genera of morels and false morels that

Table 2. Collection totals for false morels for each year 1984–1995.

	Verpa bohemica	*Verpa conica*	*Gyromitra brunnea*	*Gyromitra caroliniana*	Total
1984	0	11	55	8	74
1985	1	0	10	2	13
1986	2	16	78	4	100
1987	0	1	30	6	37
1988	1	1	5	0	7
1989	0	1	4	9	14
1990	0	0	13	12	25
1991	0	5	26	7	38
1992	0	0	24	12	36
1993	2	4	3	1	10
1994	0	4	3	0	7
1995	0	3	4	3	10
Total	6	46	255	64	371

occur in Iowa in the spring and that were investigated in the survey will be discussed individually. The technical descriptive information for each species is a summary of information from various sources (Breitenbach and Kranzlin 1984, Dennis 1981, Groves and Haave 1953, Huffman et al. 1989, Seaver 1910, Smith and Weber 1980, Weber 1995) including data from this study.

I *Morchella esculenta* group

Morel hunters in Iowa commonly recognize as three species the complex labeled the gray to yellow group of *Morchella* species or the *Morchella esculenta* complex (Yoon et al. 1990). The three species are considered by some collectors as different and easily recognizable, with a definite time sequence each season. Others consider the three species to be portions of one extremely variable species, perhaps with three varieties, with slightly different environmental requirements. This field study was not designed to address this question. The collections have been identified and recorded as three distinct but possibly overlapping species and county incidence has been separately presented with each species discussion (Figs. 10–12). In addition, we have combined the data for all three species in one group distribution map (Fig. 13). While all species of *Morchella* are edible, the *M. esculenta* group are considered by most collectors to be preferred for excellent flavor.

Morchella deliciosa Fr. (Fig. 1), commonly labeled the little grey morel or white morel, was originally described in Europe. In North America Smith et al. (1981) has reported it to be more common east of the Great Plains. It is listed as occurring in California in guide books on California fungi (Glick 1979, Orr and Orr 1979, Arora 1986).

Cap 2–3 cm long by 1–2 cm wide, conic with elongate pits with white ridges delimiting gray pits; stalk 2–3 cm long, whitish to cream, hollow; ascospores are 20–24 × 10–12 μm, elliptical, smooth, hyaline; paraphyses numerous, dilutely colored, slightly enlarged at apex; spore print yellow.

M. deliciosa is the smallest member of this group of morels and the cap with the white ridges and grey pits blends well with the bleached overwintered leaf debris on the forest floor. Also they may simply push up against the overlying litter but not be tall enough to break through it. The "little gray" is the earliest morel in Iowa, but in some parts of the United States it is reported to be the last species to develop in the spring (Weber and Smith 1985; Glick 1979). There are conflicting reports in the literature concerning the mature appearance of this morel. Initially gray fruiting bodies produced in culture have been reported by Ower (1982) to become yellow with age, finally becoming indistinguishable from *M. esculenta*. The majority of the specimens of *M. deliciosa* that were analyzed in this project were young and did not have mature ascospores in the asci, indeed many had asci so young that ascospores were not yet delimited.

Fig. 1. *Morchella deliciosa.*

M. deliciosa has been documented to occur in 56 counties in Iowa (Fig. 10). It was not collected in the northwestern counties. Collectors reported finding *M. deliciosa* in the vicinity of 21 different plants,

Table 3. Dates of first collection and last collection for each species for each year, 1984–1993.

	M. del.[a]	*M. esc.*[b]	*M. cra.*[c]	*M. semi.*[d]	*M. ang.*[e]	*V. con.*[f]	*V. boh.*[g]	*G. bru.*[h]	*G. car.*[i]
Earliest date 1984–1993	6 April	14 April	30 April	18 April	19 April	17 April	1 April	16 April	11 April
Latest date 1984–1993	26 May	10 June	27 May	26 May	14 May	17 May	4 May	27 May	17 May
Average 1st day found	22 April	25 April	8 May	6 May	2 May	1 May	22 April	21 April	22 April
Average last day found	15 May	22 May	20 May	14 May	3 May	4 May	28 April	13 May	5 May

[a]*M. del. - Morchella deliciosa*
[b]*M. esc. - Morchella esculenta*
[c]*M. cra. - Morchella crassipes*
[d]*M. semi. - Morchella semilibera*
[e]*M. ang. - Morchella angusticeps*
[f]*V. con. - Verpa conica*
[g]*V. boh. - Verpa bohemica*
[h]*G. bru. - Gyromitra brunnea*
[i]*G. car. - Gyromitra caroliniana*

Fig. 2. *Morchella esculenta.*

with oaks (*Quercus* spp.) and live or dead elms (*Ulmus* spp.) the most frequent associates. However, maples (*Acer* spp.), butternut (*Carya cordiformis* (Wang.) K. Koch, cottonwood (*Populus deltoides* Bartram ex Marsh., ash (*Fraxinus* sp.), juniper (*Juniperus virginiana* L.) and honey locust (*Gleditsia triacanthos L.*)were each reported at least twice from *M. deliciosa* sites. Slopes were the commonest field site reported, but flood plains, ridge tops and sandy areas were all reported sites by at least one collector.

The earliest collection of *M. deliciosa* reported during the survey was on 6 April in Decatur County in south central Iowa and the latest on 26 May in Plymouth County in northwest Iowa (Table 3).

Morchella esculenta Fr. (Fig. 2), the common yellow or tan morel, was also originally described from Europe. It is reported to be distributed throughout North America (Miller 1980) and Europe (Breitenbach and Kränzlin 1994; Dennis 1981). Smith et al. (1981) suggest that while it is widespread throughout North America, it is especially common east of the Great Plains.

Cap 3–9 cm long by 2–5 cm wide, subglobose to elongate with irregularly elongate yellow to yellow brown pits with paler ridges; stalk 4–6 cm by 1.5–3 cm, slightly larger at base, white to cream, hollow; ascospores 20–25 × 12–16 μm, elliptical, smooth, hyaline; paraphyses numerous, dilutely colored, slightly enlarged at apex; spore print yellow.

M. esculenta is the most commonly collected morel in the state (Fig. 11) and has been documented in this study from 74 counties. It seems to be less common in the western counties with fewer wooded areas as well as lower rainfall, but is well established in bottom land areas along the Missouri River on the western border of the state.

M. esculenta was reported from the vicinity of 19 woody plant species. Elms (*Ulmus* spp.), live and dead, were by far the most commonly mentioned with oak (*Quercus* spp.)next. Other plants reported at least twice were pines (*Pinus* spp.), cottonwood (*Populus deltoides* L.), soft maple (*Acer saccharinum* L.) and hickory (*Carya* spp.). Elms have long been the indicator tree for many morel hunters. While the data from this survey have also indicated elms as the plant most frequently associated with morels, obviously morels do occur in the vicinity of a number of other plants. Even more interesting is the information concerning sites. Morels have traditionally been considered to be fungi of wooded areas, and terrain reports in this survey indicated that the majority of collections were made on slopes in the woods. However, a number of reports were from river bottomlands, such as along the Missouri River, along fence rows with young trees and from the edges of woods. They were also reported from lawns, apparently not in close association with trees and several collections in different years were from native prairies in different regions of the state.

The earliest collection date reported for *M. esculenta* was 14 April in Decatur County in extreme south central Iowa (Table 3). The latest report was a collection made on 10 June from Winneshiek County in northeastern Iowa.

Morchella crassipes (Vent.: Fr.) Pers. (Fig. 3), called bigfoot or thick-footed morel because of the pouchy enlarged base of the stalk, is also a species originally described from Europe. It is reported in mushroom guidebooks as widely distributed and common east of the Great Plains (Smith et al. 1981).

Cap 5–18 cm long by 4–8 cm wide, subconic with roundish to elongate pits, tan to yellowish; stalk 6–13 by 3–6 cm, often columnar to folded at the base, often mealy to scurfy at least at base, pale cream colored; ascopores 20–22 × 12–14 μm, elliptical, smooth, hyaline, one-celled; paraphyses light colored, slightly enlarged at apex; spore print cream.

Fig. 3. *Morchella crassipes.*

Fig. 4. *Morchella angusticeps.*

M. crassipes is the last of this three species group to be reported in Iowa and is not as common as *M. deliciosa* or *M. esculenta.* The earliest report was on 30 April in Muscatine County in southern Iowa; the last was on 27 May in Boone County in central Iowa (Table 3).

M. crassipes is the largest of the three species and the most limited in distribution (Fig. 12). It was not reported from the north central and northwestern areas of the state. Most of the specimens of this species did not have plant and site information included. Several contributors sent descriptions and site information, but reported eating the specimens.

Single specimen collections of unusually large morels were made in June, 1994 and June, 1995. The 1994 collection, made on 5 June in a storage shed, was 15 inches tall, 12 inches in diameter at the base and weighed 2 pounds 2 ounces when collected. The 1995 collection, received on 15 June from Marshall County, weighed 1 pound 12 ounces and was similar in appearance to the 1994 specimen. The cap portions were rounded with a typical ridge-pit structure, the stalks were furrowed and larger at the base. Both were obviously placed in the *M. esculenta* series. States (1990) reports *M. esculenta* specimens from Arizona up to 40 cm. tall and 22 cm wide. Arora (1986) illustrates morel monstrosities on the back cover of his book that appear to be a grotesque form of one of the black morels.

These three species, *M. deliciosa, M. esculenta* and *M. crassipes* cannot be differentiated on the basis of microscopic features. The ascospores are the same morphologically and are of the same size range. Species distinctions have traditionally been based on the macroscopic features mentioned under each species. If they were interpreted as one large, extremely variable species, the composite distribution in Iowa is presented in Fig. 13.

II Black morel group

Morchella angusticeps Peck (Fig. 4), a species originally described from collections from New York, is one of a distinctly different group known as the black morels. Smith and Weber (1980) report the black morels, *M. angusticeps* and *M. conica* Pers., to be the common morels of the conifer and aspen regions of North America. Lincoff (1981) discusses *M. elata* Fr. as the black morel common in coniferous woods and in sandy soil in mixed woods. It fruits abundantly in burn areas after forest fires (Smith et al. 1981, Apfelbaum et al. 1984, Volk 1991).

Cap 2–9 cm long by 1.5–5 cm wide, narrowly conic when young, becoming broader with age, brown ranging to gray, pit areas elongate with dark brown to black ridges; stalk 1.5–6 cm by 0.5–3 cm, white to creamy to pinkish tan, scurfy to mealy, hollow; ascospores 21–24 × 12–14 μm, elliptical, one-celled, hyaline, smooth; spore print cream.

M. angusticeps has a very limited distribution in Iowa and has not been previously reported in this state. In this survey it has been documented from eight counties in the southeast and east central region (Fig. 14). This morel is quite distinctive with a darker tapered cap with black ridges, and it is likely that it would have been detected by experienced local morel hunters if it occurred in other areas. Upland oak forested areas on limestone outcroppings in Linn County have yielded more collections, more numbers of this morel in a specific year and in a larger number of years than from any other county. It was irregular in fruiting during the survey years (Table 1), a feature confirmed by discussions with local morel hunters. The earliest recorded collection was made on 19 April in Johnson County. The latest collection was made on 14 May in Iowa County (Table 3).

The black morels have been reported to be edible, but some people have reported mild digestive problems after consuming them (Weber 1995).

III *Morchella semilibera*

Morchella semilibera DC (Fig. 5), commonly known as the half-free or semi-loose morel, is a species originally described in Europe. It is

Fig. 5. *Morchella semilibera.*

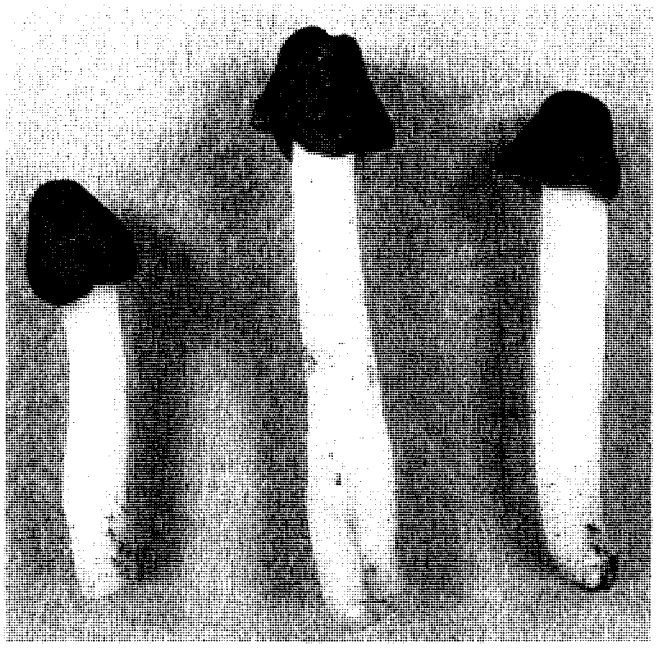

Fig. 6. *Verpa conica.*

obviously different from the other *Morchella* species and has sometimes been placed in a separate genus, *Mitrophora,* because the cap is attached to the stalk only in the apical one-third to one-half with the lower portion free or even flared away from the stalk. Smith et al. (1981) refers to *M. semilibera* as widely distributed in deciduous woods, while Lincoff (1981) reports *M. semilibera* to occur throughout eastern North America to Iowa and in the Pacific northwest.

Cap 2–4 cm long by 1.5–3 cm wide, bell shaped to conic, free from the stalk for at least half of length of the cap, pits longer than broad with long well developed ridges; stalk 6–15 by 2–3 cm, usually enlarged at base to as much as 4 cm in diameter and furrowed, whitish to yellowish, granulose to mealy; ascospores 24–34 × 15–21 μm, elliptical, hyaline, smooth; paraphyses slightly clavate, lightly colored, spore print yellow.

In Iowa, *M. semilibera* has been documented from 63 counties (Fig. 15). It has not been reported from the northwestern portion of the state. It is distinctively different from the typical morel, enough so that collectors often hesitate to eat it without asking for confirmation of identification. It has been reported to be less flavorful than the *Morchella esculenta* group by some experienced morel hunters, but is still a welcome addition to the "catch" of the average collector. The earliest record for occurrence of *M. semilibera* was on 18 April in Polk County in central Iowa; the latest collection date was 26 May in Hamilton County in central Iowa (Table 3). Several mushroom books (Glick 1979; Lincoff 1981; Smith et al. 1981) indicate that this is one of the first morels to fruit in the spring, seven to ten days before *M. esculenta* appears. It is not distinctively early in Iowa.

Morchella semilibera was found in the vicinity of several different woody plants, most frequently near live or dead elms (*Ulmus* spp.). It was reported near oak (*Quercus* spp.), hickory (*Carya* spp.) and maple (*Acer* spp.), less commonly near cottonwood (*Populus deltoides* L.), ash (*Fraxinus* spp.) and walnut (*Juglans* sp.). It occurred on slopes in the woods, with only one report of presence on a river floodplain.

IV *Verpa conica*

Verpa conica (Mull.:Fr.) Swartz (Fig. 6) was originally described in Europe, but is reported in several fungus guide books of common fungi of Europe and England to now be uncommon or rare (Breitenbach & Kränzlin 1984; Dennis 1981). It is considered by Smith & Weber (1981) and by Miller (1980) to be widely distributed and frequent in North America, but not to occur in quantity.

Cap 2 cm long by 1–3 cm wide, brown above with white lower surface, smooth or with faint furrows near margin, subconic to bell shaped, attached at top only, flaring at lower edge with age; stalk 5–11 cm long by 1–1.5 cm wide tapering upward, white to cream, loosely stuffed, stuffing breaking down with age; ascospores 8 per ascus, 20–26 × 12–16 μm, elliptical, smooth, hyaline, 1 celled; paraphyses numerous, gradually clavate; spore print light yellow. The asci and ascospores of *V. conica* are indistinguishable from those of the three species of the *M. esculenta* group discussed earlier.

V. conica has been documented from 30 counties in Iowa (Fig. 16). It was not collected in the north or northwestern areas of the state, with the exception of one collection from Cherokee County in 1989. Also, that was the only occurrence of *V. conica* documented in the state that year (Table 2). It was not collected consistently from the counties where it was more commonly recorded, with no reports at all in three years of the survey, and with only one collection in each of another three years. *V. conica* was reported from the vicinity of elms (*Ulmus* spp.), dead and living, also one report each of collection under oak (*Quercus* spp.), hickory (*Carya* spp.), mulberry (*Morus* spp.) and basswood (*Tilia americana* L.). It was found on slopes in deciduous woods.

The earliest collections were reported on 17 April from Keokuk County in southeastern Iowa (Table 3). The latest recorded was from Appanoose County in south central Iowa on 17 May. Information on edibility is limited and not encouraging, perhaps because of its less attractive appearance and its random fruiting.

V *Verpa bohemica*

Verpa bohemica (Krombh.) Schroet. (Fig. 7), often called the early morel, also is a European species. It usually occurs along streams in moist rich woods in very early spring in the northern part the United States. It is not reported from the southern United States by Weber

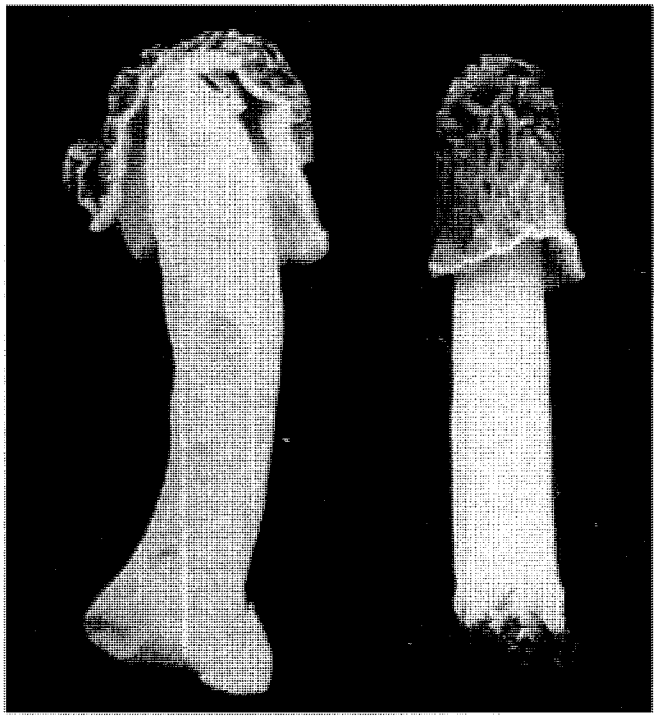

Fig. 7. *Verpa bohemica.*

and Smith (1985) nor from Texas (Metzler and Metzler 1992) or Kansas (Horn et al. 1993).

Cap 2–5 cm long by 2–4 cm wide, conic to bell shaped, attached at top only, yellow-brown to reddish-brown to brown, folded with longitudinal ridges that frequently anastamose to form a ridge-pit pattern; stalk 6–12 cm × 1–2.5 cm, slightly larger at base, white to cream, smooth, loosely stuffed, becoming hollow with age; ascospores 2 per ascus, 60–80 × 15–18 μm, elliptical, smooth, hyaline to yellowish; paraphyses enlarged at apex, numerous; spore print yellow. The large ascospores, the limited number of ascospores, two per ascus, and the gyrosely furrowed cap characterize this species and make separation from *Verpa conica* an easy decision. This species could be confused with *Morchella semilibera* if specimens were not examined carefully, but the cap attached only at the stalk apex and the stuffed stalk of *V. bohemica* are significantly differentiating field characteristics. The large ascospores, two per ascus, are diagnostic of *V. bohemica* because all species of *Morchella* and *Verpa conica* have eight smaller, elliptical ascospores per ascus.

Verpa bohemica has been reported from only five counties in northeastern Iowa, from Des Moines County in southeastern Iowa and from Harrison County in far west central Iowa (Fig. 17). Only six collections were seen in the 10 years of the survey, and each collection consisted of only one or two individuals. Collections on which we have information were found in upland oak forests.

The earliest collection of *V. bohemica* was from Winneshiek County in northeast Iowa on 1 April (Table 3) and the latest on 4 May from Worth County in north central Iowa.

Verpa bohemica has been eaten, even recommended in some discussions, but it may cause gastrointestinal upset and affect muscular coordination (Smith and Weber 1980). Illness seems to have occurred when larger quantities were eaten. It cannot be recommended without reservation.

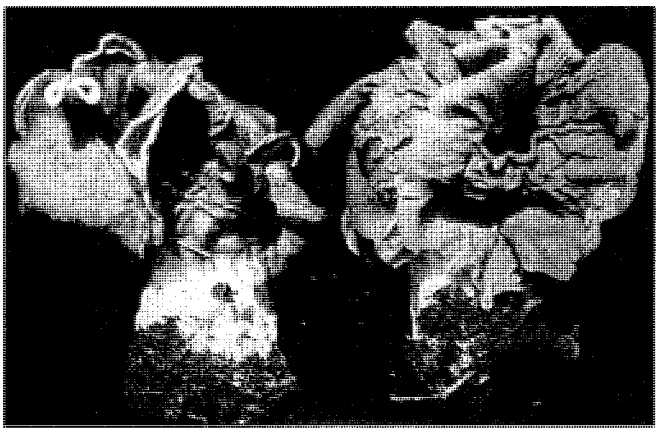

Fig. 8. *Gyromitra brunnea.*

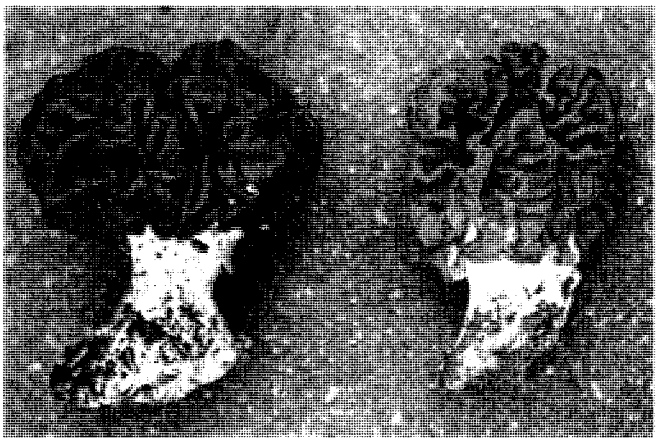

Fig. 9. *Gyromitra caroliniana.*

VI *Gyromitra brunnea*

Gyromitra brunnea Underw. (Fig. 8), commonly known as a false morel or beefsteak morel, is a North American species.. It has also been interpreted as *Gyromitra fastigiata* (Krombholz) Rehm, an European species.

It probably occurs only east of the Rocky Mountains. McKnight (1973) reports occurrence of *G. brunnea* on soil or well rotted wood in hardwood forests from Oklahoma to Iowa eastward and northward to the Great Lakes. This distribution is supported by other discussions.

Cap 5–12 cm broad and high, irregularly lobed to vaguely saddle shaped, reddish to dark brown, becoming darker with age; stalk 6–9 cm long by 2–5 cm wide, slightly enlarged at base, white, ribbed or fluted sometimes with anastomosing ridges, usually loosely stuffed; ascospores 8/ascus, 28–30 × 12–15 μm, elliptical, wall sculptured with fine warts or faint reticulations, usually with two or three large oil drops at maturity; paraphyses numerous, pigmented, enlarged at apex; spore print light yellow.

This species is the most common false morel in eastern and central Iowa, occurring consistently in the wooded Des Moines River valley from Webster County south to the Mississippi River (Fig. 18). It was collected in 60 counties and it was usually present in southern Iowa counties, developing regularly in southwestern Iowa in the wooded loess hills bluffs in Fremont County. It was never collected in the northcentral or northwest area of Iowa. It is large and would have been noticed by morel hunters.

The earliest collection was made on 16 April in Lee County in southeast Iowa (Table 3). The latest collection was made on 27 May in Allamakee County in northeast Iowa.

G. brunnea was typically associated with oak (*Quercus* spp.). Reports cited presence of living oak trees, dead oaks, rotting logs and stumps in the vicinity of collections. Often a number of false morels would be clustered near rotting oak logs or stumps rather than the development of a single fruiting body. Reports also indicated occurrence near living or dead elms (*Ulmus* spp.); maples (*Acer* spp.), hickory (*Carya* spp.), cottonwood (*Populus deltoides* L.) and basswood (*Tilia americana* L.). Gooseberry bushes (*Ribes* spp.) and Mayapple (*Podophyllum peltatum* L.) were mentioned in the sites also. It develops preferentially on wooded slopes, seldom in flood plains.

The development of a group of *G. brunnea* fruiting bodies around a well rotted oak stump in a deciduous woods near Ames, in Story County was monitored. They attained full size rapidly, within a week after the initial observations. The light reddish brown caps darkened to a rich mahogany brown with age as pigments developed in the paraphyses. The ascospores developed slowly, attaining mature wall markings and characteristic large oil drops only after three to four weeks. A similar opportunity to follow ascospore development in any of the true morels was not possible, but many of the morels contributed for the survey had asci with mature or almost mature ascospores. Many of the *G. brunnea* collections sent to us lacked mature ascospores.

Gyromitra brunnea cannot be recommended for eating because of the possibility of the presence of the toxin monomethylhydrazine or its precursors (Miller 1980).

VII *Gyromitra caroliniana*

Gyromitra caroliniana (Basc.:Fr.) Fr. (Fig. 9) is a species that seems to be limited to North America. It occurs in rich hardwood forests in eastern North America, not in the coastal plain and high mountains, and it is common in the southern states (Smith and Weber 1980; Weber and Smith 1985). McKnight (1973) reports it from hardwood forests, from Oklahoma to South Carolina and north almost to the Great Lakes.

Cap 10–20 cm broad by 5–25 cm high, deeply wrinkled and convoluted, dark red-brown to brown; stalk 8–10 cm long by 3–5 cm wide, furrowed, enlarged at base, white to cream; ascospores 25–30 × 12–14 μm, elliptical, usually with at least 2 large oil drops, hyaline, finely warted with one to several short apiculi on ends; paraphyses numerous, pigmented; spore print light yellow.

G. caroliniana is much less common in Iowa than *G. brunnea.* It was collected in 28 counties, occurring most consistently in south central and southeastern Iowa (Fig. 19). Over the 10 years of the survey we have recorded a few single specimen-single year collections from scattered counties in central Iowa, but none from the northern or northwestern counties. *G. caroliniana* was collected on 11 April in Lee County in southeastern Iowa (Table 3). The latest recorded collection was on 17 May in Appanoose County in south central Iowa. Some spectacular specimens of *G. caroliniana* were received. The largest one had a cap 23 × 17 cm, with a stalk 8 cm wide and cut off at 10.5 cm. It weighed six pounds when collected in Wapello County in southeastern Iowa on 27 April 1992.

G. caroliniana does not seem to be associated with any particular trees or habitats, at least not from our limited information. Collectors reported it from the vicinity of cottonwood (*Populus deltoides* L.), oak (*Quercus* spp.), osage orange (*Maclura pomifera* (Raf.) C.K. Schneid.), and elm (*Ulmus* spp.) with equal numbers. Also occurrences were reported with equal frequency from wooded slopes and flood plains.

Eating either *G. brunnea* or G. caroliniana is not recommended because of the possibility of the presence of toxins. While some species of *Gyromitra* that occur in the mountains of the western United States are reported to be edible, other *Gyromitra* spp. that occur in the United States and in Europe are poisonous.

DISCUSSION

A basic question addressed in this field research project was the distribution of morels and false morels in Iowa.

Morchella esculenta was the most widely distributed species of *Morchella* in Iowa and occurred in the greatest numbers at individual collection sites. The documented presence in 74 counties suggests that it could likely be found in any county in Iowa. It does seem to be more common in the southern half of the state and along the Mississippi and Missouri Rivers on the eastern and western borders.

Morchella deliciosa has a similar distribution but was reported less frequently. The smaller size of this species, plus the colors which blend easily with the background of overwintered leaves may well contribute to difficulties in finding these morels. The dates of first collection (Table 3) of *M. esculenta* and *M. deliciosa* during the ten survey years indicate that they are found by collectors in overlapping periods of time with *M. deliciosa* usually occurring a few days earlier.

Morchella crassipes is much less common than the other two species of the *Morchella esculenta* complex. It was most frequently reported from the eastern fourth of the state, along the Des Moines River from Webster to Lee Counties, and occasionally along the Missouri River.

The question of speciation in the *Morchella esculenta- M. deliciosa-M. crassipes* complex has been debated frequently and fervently. Certainly morel hunters each season encounter many morels that easily can be placed in one of the three species on their field appearance—size, color, conformation. Also, it is not uncommon to find individual morels that are intermediate in these definitive macroscopic features and are not readily assigned a species name. There are no differences in ascospores, paraphyses or other microscopic features that are useful in distinguishing among these three species.

There are conflicting reports concerning change as individual morels mature. Some observers (Weber 1995) state that they have watched individual morels that were typical *"deliciosa"*, small with gray pit areas delimited by white ridges when young, change to appropriate typical *"esculenta"*, larger with yellow to tan pit areas with somewhat similarly colored ridges, at maturity. However, others have watched individual morels from emergence to maturity, often for a period of more than a week that maintain the characteristic features throughout, always readily recognized as *M. deliciosa* or *M. esculenta.* Martin (1960) commented that he had collected *M. deliciosa* nearly every spring for a number of years under a couple of old apple trees in Iowa City where it fruited with *M. semilibera, Verpa conica* and *Monilinia fructicola* (G. Wint.) Honey. It usually appeared about the first of May, a week or ten days before *M. esculenta.* Martin never collected *M. esculenta* in this spot, but *M. esculenta* occurred regularly in an area approximately 300 yards distant. There is little information from the field for *M. crassipes* development and change.

Various investigators using modern molecular analysis techniques to add information for defining and delimiting species in this complex have supported the concept of a single extremely variable population. Volk and Leonard (1989) conducted laboratory experiments based on mycelial reactions and suggested that the three species are conspecific. This concept has been supported by Jung et al. (1993) using an enzyme-linked immunasorbent assay (ELISA), by Gessner et al. (1987) using enzyme electrophoresis with morphologically identified populations of *M. deliciosa* and *M. esculenta,* by Yoon et al. (1990) who looked at allele frequencies in populations of *M. deliciosa* and *M. esculenta,* by Royse and May (1990) as determined by multilocus enzyme electrophoresis, and by Bunyard et al. (1994) using RFLP analysis.

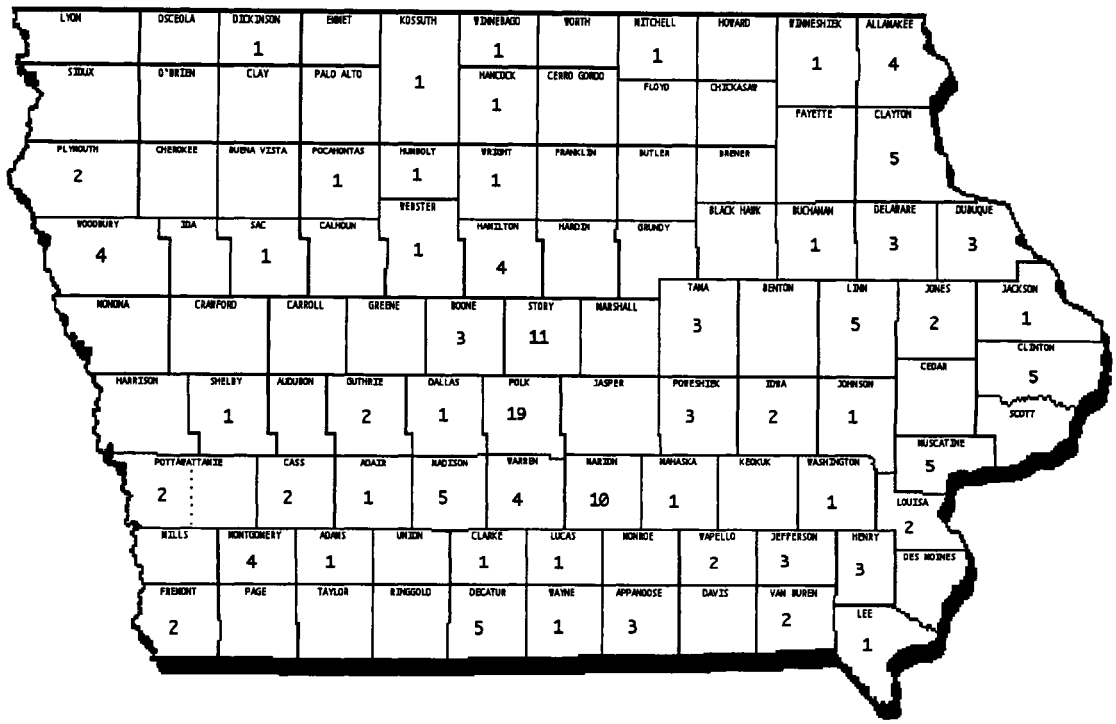

Fig. 10. *Morchella deliciosa.* Collections by county, Iowa, 1984–1995.

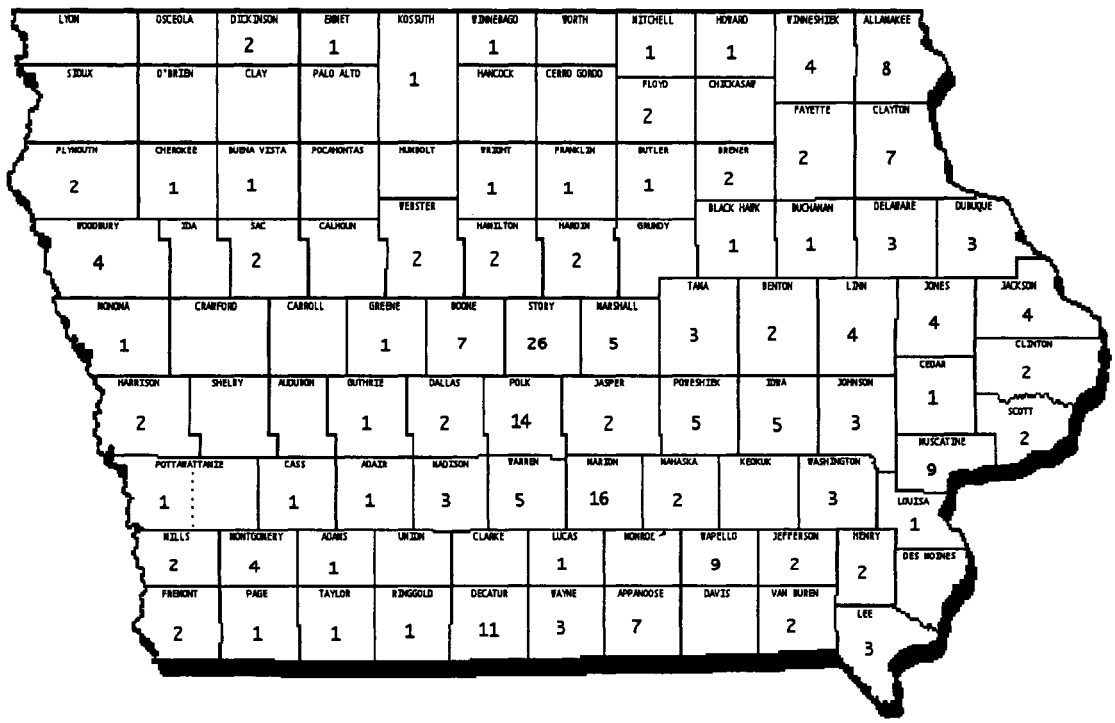

Fig. 11. *Morchella esculenta.* Collections by county, Iowa, 1984–1995.

The black morel group had not been reported to occur in Iowa prior to this study, although veteran morel hunters in the Linn County area have commented that they have seen it in small numbers in some years. Of the species considered in the black morel group, our Iowa material appears to be *M. angusticeps.* It has been recorded from a cluster of counties around Linn County in far east central Iowa in small numbers in only six of the ten survey years, and was not reported in either 1994 or 1995.

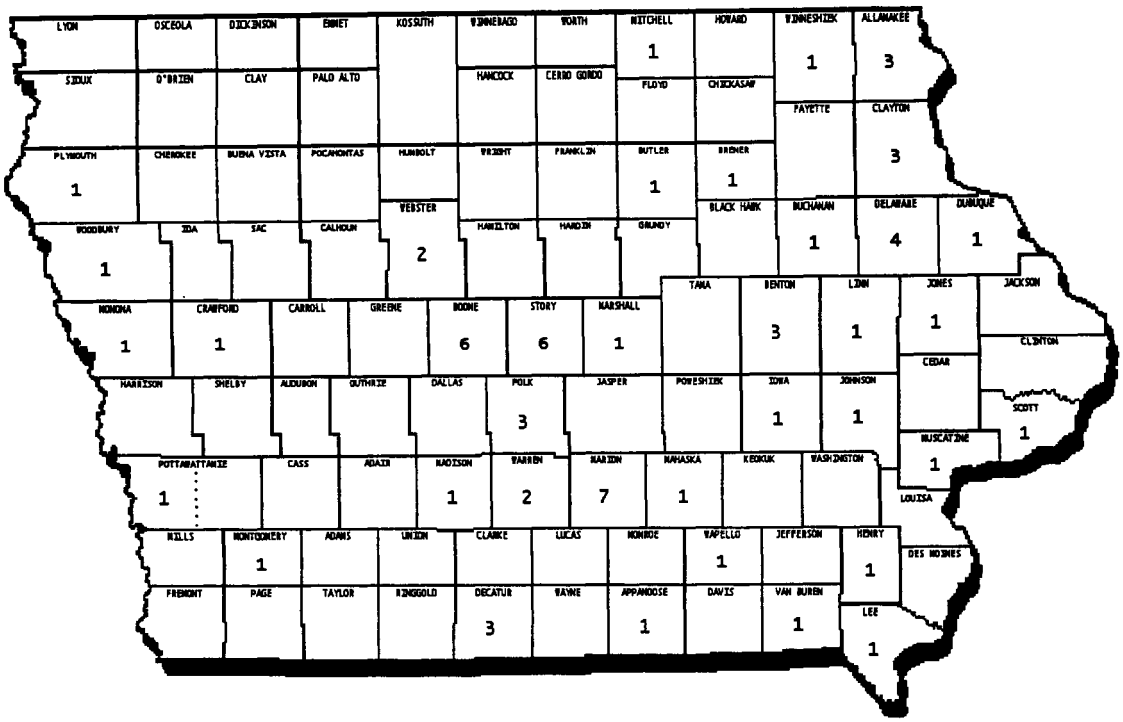

Fig. 12. *Morchella crassipes.* Collections by county, Iowa, 1984–1995.

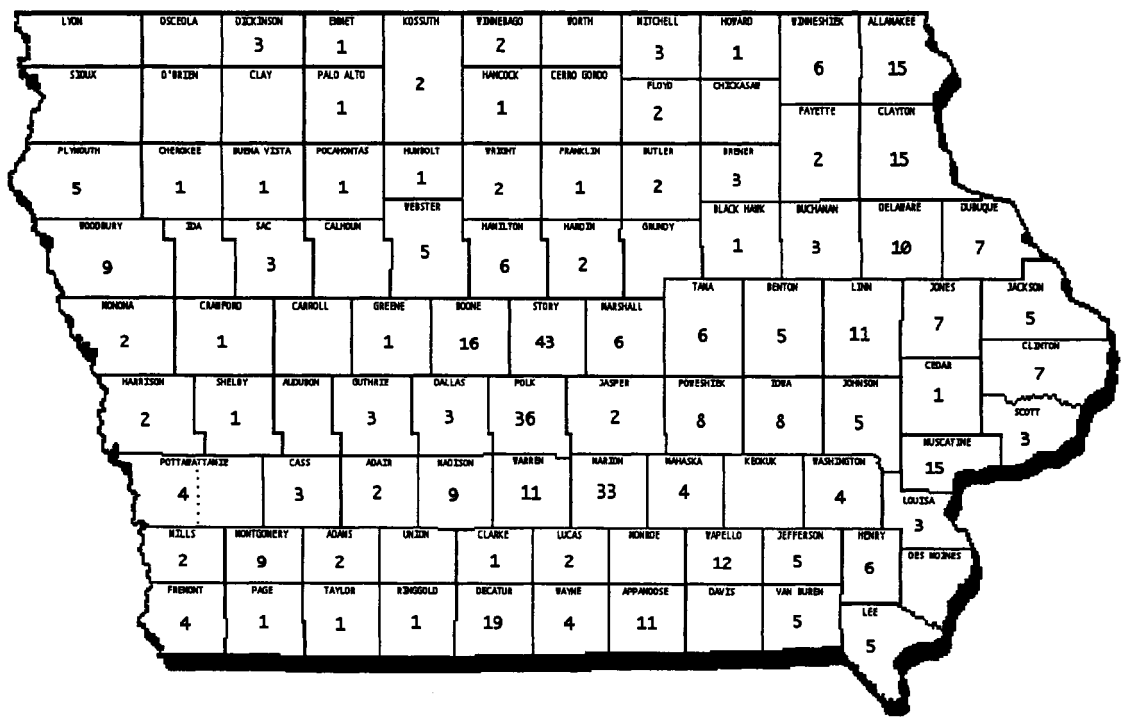

Fig. 13. *Morchella esculenta* group. Collections by county, Iowa, 1984–1995.

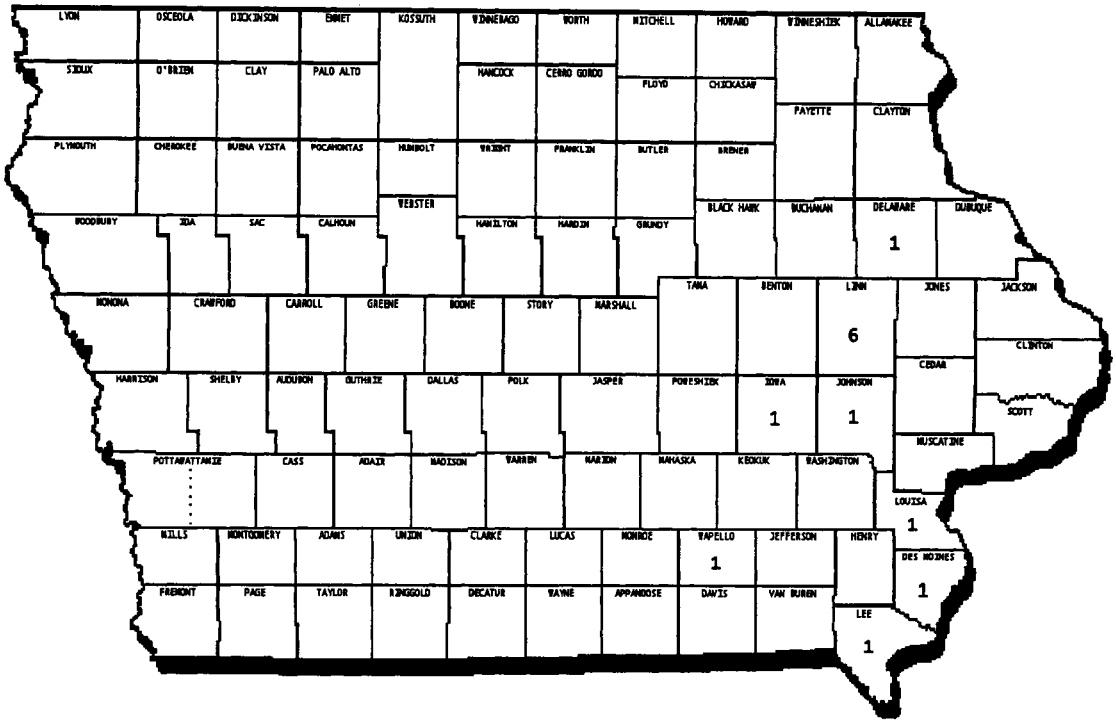

Fig. 14. *Morchella angusticeps.* Collections by county, Iowa, 1984–1995.

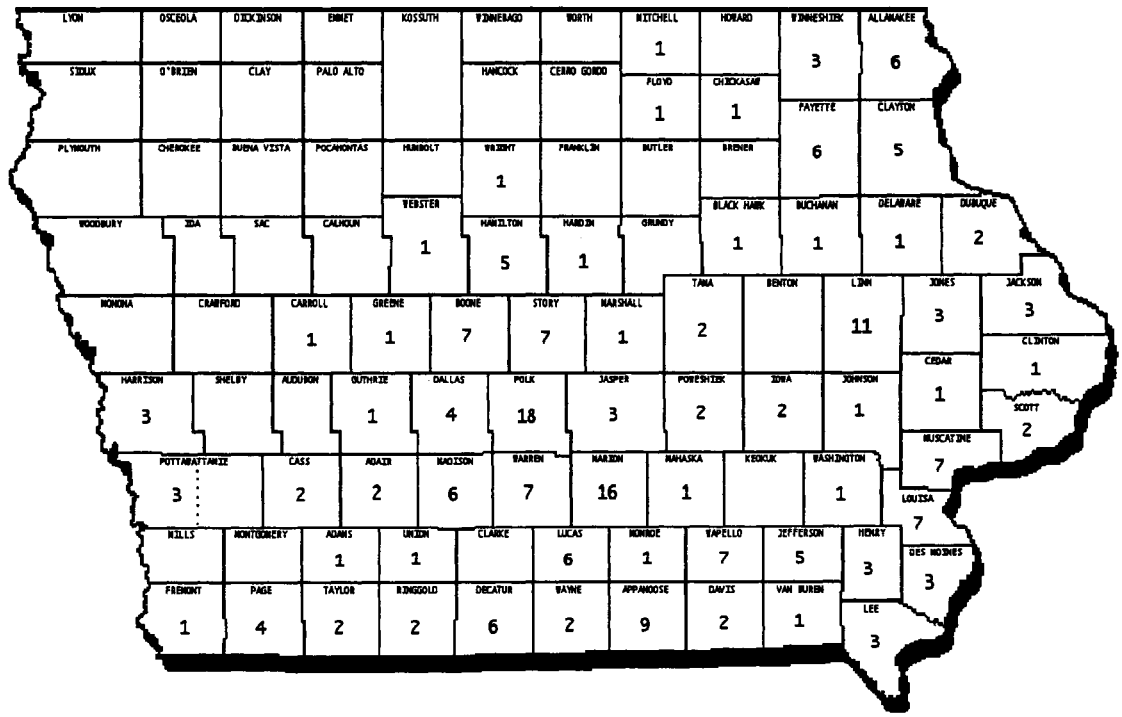

Fig. 15. *Morchella semilibera.* Collections by county, Iowa, 1984–1995.

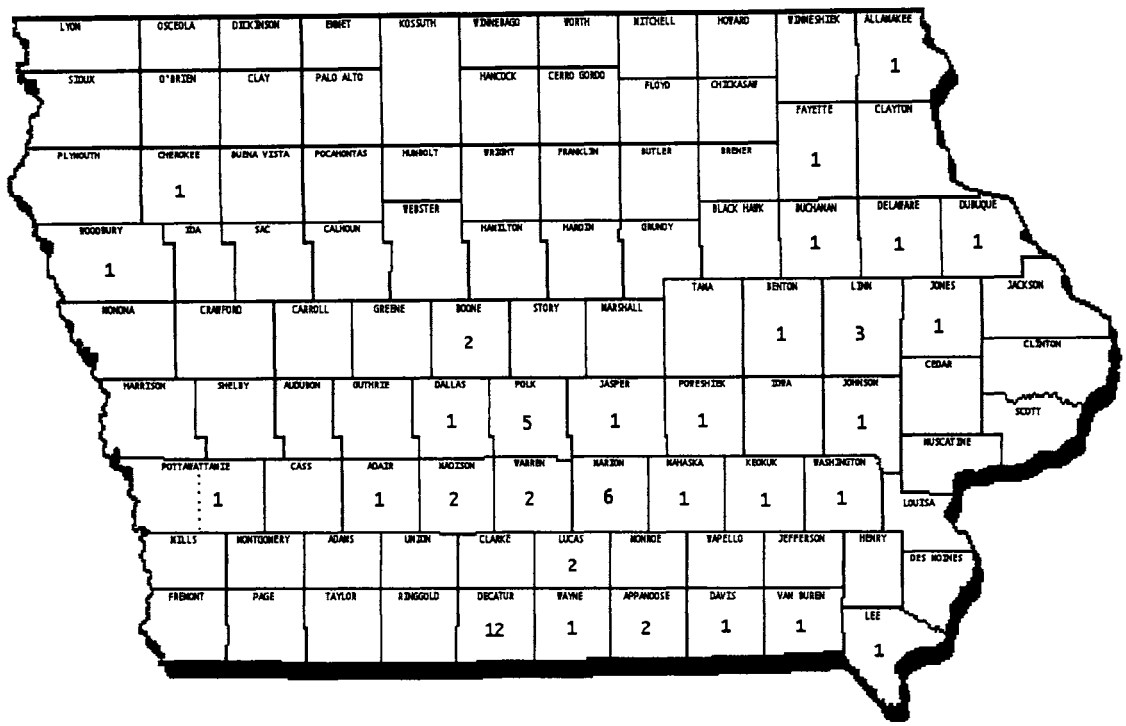

Fig. 16. *Verpa conica.* Collections by county, Iowa, 1984–1995.

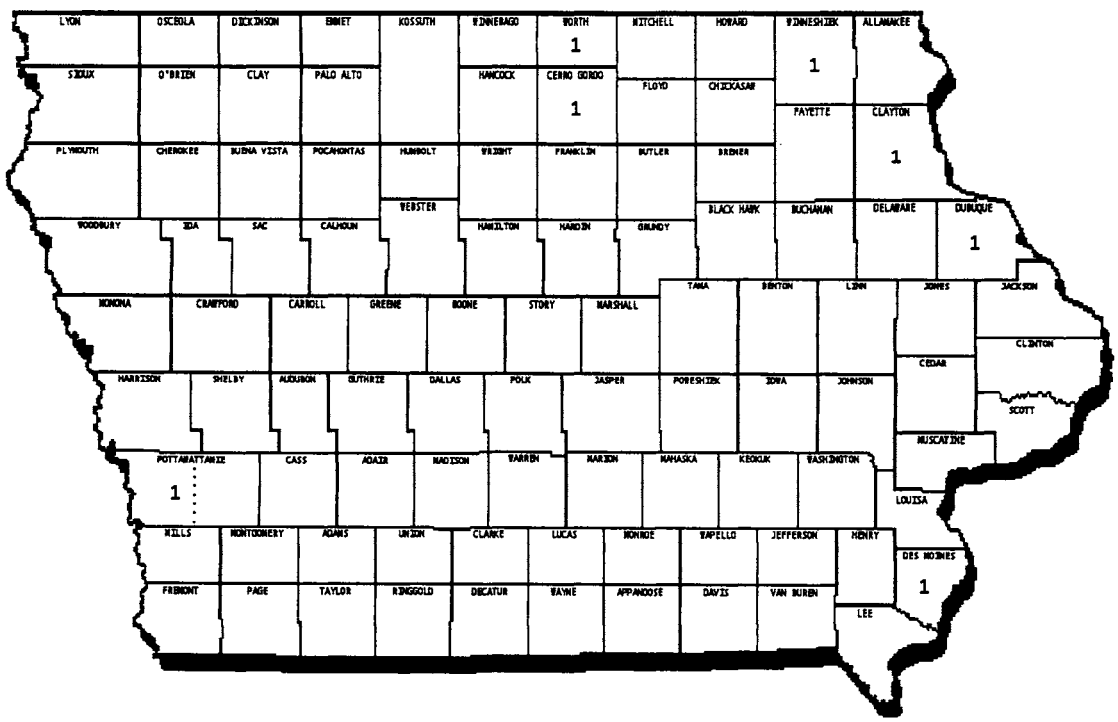

Fig. 17. *Verpa bohemica.* Collections by county, Iowa, 1984–1995.

Morchella semilibera was not recorded from the northwest and north central portions of the state. It may be more closely associated with wooded areas along rivers and streams than are the other common morels. It seems to be abundant in some years.

Verpa conica was not found with any frequency except in the most productive collecting year of the survey, 1986. It occurs sporadically in far eastern Iowa and in south central Iowa. It was reported from only a single site along the Missouri River in western Iowa, and also

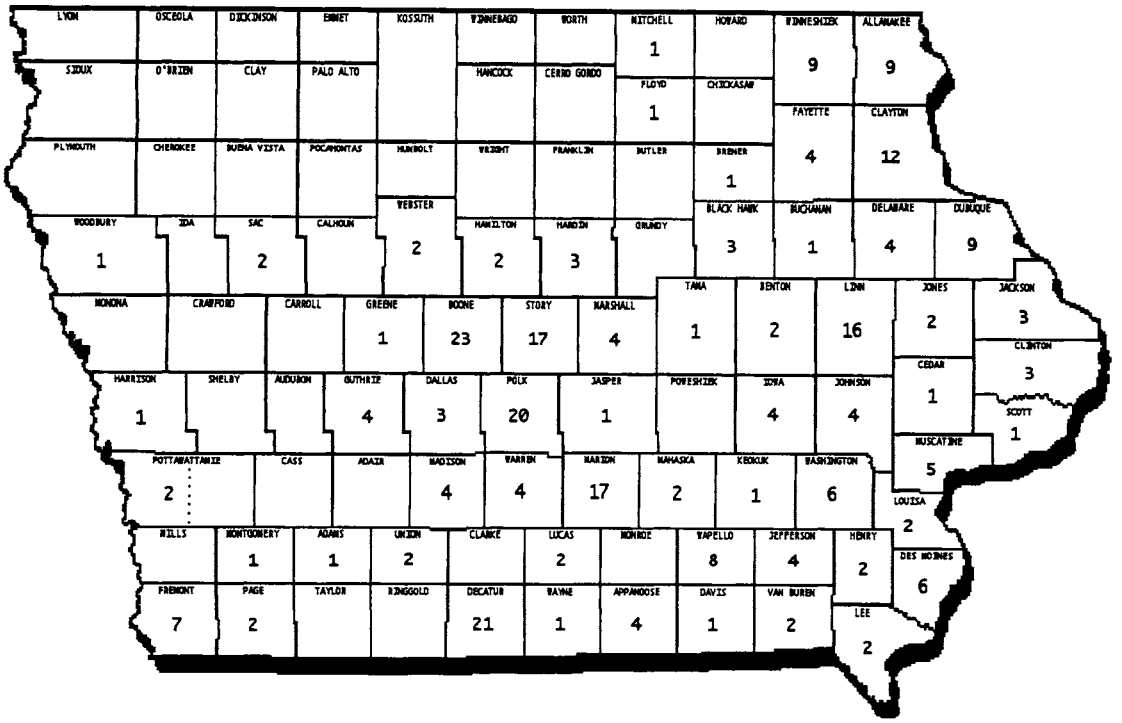

Fig. 18. *Gyromitra brunnea.* Collections by county, Iowa, 1984–1995.

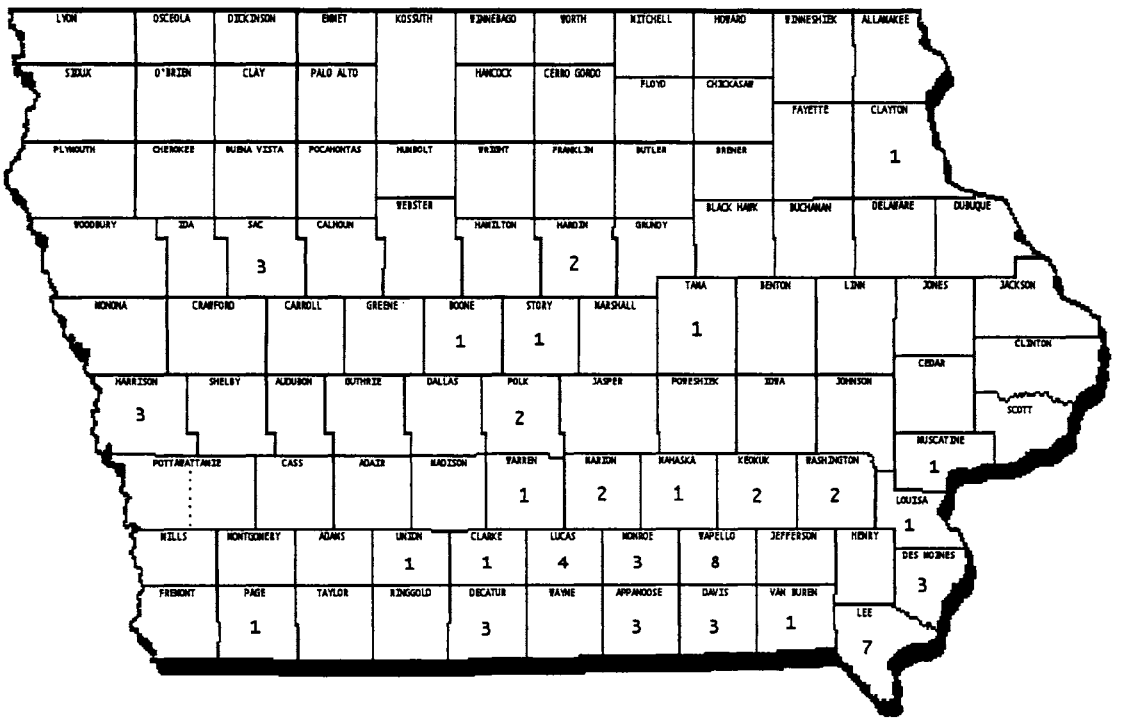

Fig. 19. *Gyromitra caroliniana.* Collections by county, Iowa, 1984–1995.

was not reported from the north central and northwest portions of the state.

Verpa bohemica is an uncommon fungus in Iowa. It was collected in very small numbers, only six total, in four of the ten survey years. Five of the county sites are in northeastern Iowa, one in southeastern Iowa along the Des Moines River, and one in southwestern Iowa in Pottawattamie County. All collections were in April or very early May, a timing that would be expected when

considering the frequent comments labeling this species as the "early" morel.

Gyromitra brunnea is the common false morel in Iowa. It seems to be absent from the northwest and north central areas of the state, but is commonly found in the rest of the state. Collectors often reported clusters of up to ten to thirty false morels clustered around a rotted oak stump or oak log.

Gyromitra caroliniana has been considered to be the southern false morel, and was collected most extensively in southeastern Iowa. It seems to be absent from the northern and northwestern areas, with the exception of large handsome specimens from Sac County. *G. caroliniana* seemed to fruit singly or in very small groups.

The infrequent fruiting and somewhat haphazard distribution patterns recorded during the survey are not abnormal patterns for basidiomycetous fungi that grow on plant debris on the ground or in the soil in wooded to sparsely wooded areas. The vegetative portion of these fungi survives perennially in such habitats, sometimes in mycorrhizal associations with living roots of vascular plants in the area, sometimes with wood or other plant debris. If environmental conditions are unfavorable and fruiting bodies are not developed, the fungus still persists in the area, not dependent on fruiting each year for survival. These ascomycetous fungi may well have similar potential for vegetative survival.

In stable forest ecosystems, morels may form storage organs such as sclerotia (Volk, 1991) free or around tree roots, particularly if the roots are mycorrhizal with other fungi (Buscot and Roux 1987, Buscot 1989, Buscot and Kottke 1990, Buscot and Bernillon 1991). Morel mycelium also may develop in established mycorrhizae as secondary mycorrhizal partners (Buscot 1992). These associations seem to provide the resources for the early spring development of morels.

Spring development of morels is certainly affected by rainfall and temperature. Both components must be in a reasonably favorable balance before development proceeds, and either may be limiting. The higher average rainfall of eastern Iowa and the larger extent of forested habitat would cause one to expect larger and more frequent spring populations of morels and false morels in that portion of the state. The effect of fall rains is an unknown factor. Perhaps certain rainfall levels or certain combinations of environmental factors are more favorable; thus, slopes or river bottom areas may be better habitats depending on such factors or combinations of factors.

Certainly the number of specimens we received in this survey was affected by the number of morel hunters in the field. In some Iowa counties, perhaps particularly western counties not bordering the Missouri River, the scarcity of wooded areas, the traditional morel- false morel habitat, has resulted in morel hunting being less rewarding and a less established tradition.

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