Chapter 10
Mediterranean Basin: North Africa

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10.1 Introduction

Mediterranean countries, including those of North Africa, are the location of an abundant harvest of edible truffles known by several different names: "Terfass," "Torfàs," "Kama," "Kame," "Kholassi," "Zubaidi," "desert truffles," and "sand truffles." Because of their pale coloration they are often called "white truffles" (Maublanc 1946, 1952).

These names refer to a variety of edible mushrooms, which are less appreciated as compared to the true (forest) truffles (Maublanc 1946, 1952). They were classified along with forest truffles, into the Tuberales (Janex-Favre and Parguey-Leduc 1985; Parguey-Leduc et al. 1987a, b, 1988, 1989, 1990; Janex-Favre et al. 1988; Khabar et al. 1994) to form a distinct family Terfeziaceae (Trappe 1979). This order Tuberales was, however, abandoned and members were moved into of the order Pezizales (Korf 1973; Trappe 1979; Donadini 1983).

The genera *Delastria*, *Terfezia*, *Tirmania*, *Picoa*, *Balsamia,* and *Melanogaster* were placed in the Terfeziaceae family within this order.

The Bataille key (1922) includes thirteen species and four varieties. Chatin (1891a, b, 1896a, b, c), Maire (1907, 1933), Maire and Werner (1937), Malençon (1973), Alsheikh and Trappe (1983), and Khabar et al. (2001) added to the list several other species found in Morocco, North Africa, and the Middle East.

"Desert truffles" or "Terfass" are collected in semiarid and arid areas with hot climates. Countries around the Mediterranean, especially in North Africa and the Middle East, are renowned for their desert truffle yields. The following species have been reported from North Africa (Algeria, Morocco, Libya, Tunisia, and Egypt) by Chatin (1891a, b, 1896b), Patouillard (1894a, b), Maire (1906, 1907, 1933), Maire and Werner (1937), Malençon (1973), Khabar (1984, 1988), Fortas and Chevalier

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(1990), El-Kholy and Assim (1991), Pacioni and El-Kholy (1994), Moawad et al. (1997), Ali et al. (1998), Khabar and Najim (1999), Khabar et al. (1994, 1999, 2001, 2005), and Slama et al. (2006): *Terfezia boudieri*, *T. goffartii*, *T. leptoderma* and *T. arenaria*, *T. leonis*, *T. leonis* var. *heterospora* and *T. mellerionis*, *T. claveryi* (="red Terfass" of Tafilalet), *Tirmania nivea* and *T. pinoyi* (="white Terfass" or "Zoubaïdi"), *Picoa juniperi,* and *P. carthusiana*. We note that many varieties and species have been revised or abandoned.

Some species of desert truffles are found outside of North Africa: in the Middle East (Saudi Arabia, Iraq, Iran, Kuwait, Syria, Israel, etc.) as well as in European countries in the Mediterranean basin (the south of Italy, Spain and France, Portugal, Greece) (Tulasne and Tulasne 1851; Moyen 1889; Chatin 1891a, b, 1896a, b, c; Patouillard 1894a, b; Fischer 1897; Mattirolo 1905, 1922; Bataille 1922; Maublanc 1927, 1946; Imai 1933; Rayss 1959; Bresadola 1960; Ceruti 1960; Trappe 1971, 1979; Malençon 1973; Calonge 1982; Calonge et al. 1985; Donadini 1979, 1986; Langiu 1979; Pacioni 1979; Awameh and Alsheikh 1980a, b; Binyamini 1980; Girel 1980; Castro and Freire 1982; Moustafa 1985; Moreno et al. 1986; Bokhary 1987; Bokhary and Parvez 1988; Rueda and De Rueda 1989; Daneshpazhuh 1991; Ewaze et al. 1991; Hashem and Al-Homaidan 1991; El-Kholy et al. 1992a, b, c; Honrubia et al. 1992; Pacioni and El-kholy 1994; Hashem and Al-Obaid 1997; Moawad et al. 1997; Kagan-Zur 1998; Diez et al. 1999).

Desert truffles are also found in Hungary (Kiraly and Bratek 1992; Kiraly et al. 1992; Bratek et al. 1996), Turkey (Agaoglu and Artik 1992; Afyon 1996), the Canary Islands (Korf and Zhuang 1991), India (Khare 1975), China (Bin-Cheng 1992), South Africa (Marasas and Trappe 1973; Ackerman et al. 1975; Taylor et al. 1995; Kagan-Zur et al. 1999a, b), North America (Gilkey 1947, 1954; Knighton 1976; Trappe and Sundberg 1977), South America (Trappe 1979), Germany (Boetticher 1987), Chihuahuan Desert in Mexico (Zak and Whilford 1986), and in the Balkan Peninsula (Lawrynowicz et al. 1997).

While forest truffles such as *Tuber aestivum* and *T. rufum Pico Vitt* Syn *uncinatum* which were collected by Malençon (1973) in the middle Atlas between elevation 1,600 and 2,000 m and *T. melanosporum* recently introduced at the chain of horsts and the massive of Debdou in eastern Morocco (1,700 m) are collected in regions of subhumid to humid climate and limestone soil, desert truffles are generally harvested in semiarid or arid zones in sandy loam or sandy soils which may be slightly acidic or basic.

Truffles of the genus *Tuber* develop under poplars, oaks, olive trees, pines, chestnut, and more (Chevalier et al. 1984). Desert truffles are collected under phanerogam herbaceous plants such as Cistus (species reported are *Cistus halimifolius*, *C. ladaniferus* var. *halimioides*, *C. salicifolius*, *C. monspeliensis,* and *C. salvifolius*) and *Helianthemum* spp., detailed below (Chatin 1891a, b; Awameh and Alsheikh 1978; Awameh et al. 1979; Awameh 1981; Alsheikh 1984; Dexheimer et al. 1985) or Pins (Chevalier et al. 1984; Korf and Zhuang 1991; Janex-Favre et al. 1988; Khabar and Najim 1999; Khabar et al. 1999, 2001).

However, the desert truffle *Terfezia leptoderma*, a rather common species in southern Europe and northern Africa, was collected under *Pinus radiata,* in San Leonardo, Italy (Janex-Favre et al. 1988); under *Pinus canariensis*, in the Canary Islands (Korf and Zhuang 1991); and under *Pinus pinaster* var. *atlantica*, in the Mamora forest, Morocco (Khabar and Najim 1999; Khabar et al. 1999, 2001).

Other tree species have also been reported as host plants of desert truffles; *Robinia pseudoacacia* associated to *Terfezia terfezoides* (=*Mattirolomyces terfezioides*) (Bratek et al. 1996) as well as some oak species (Chevalier et al. 1984).

But the most common desert truffles host plants are, in general, annual or perennial herbaceous *Helianthemum* spp. (Chatin 1891a, b, 1896a, b, c; Awameh 1981; Awameh and Alsheikh 1980a, b; Alsheikh 1984; Khabar 1984, 1988; Khabar and Najim 1999; Khabar et al. 1994, 1999, 2001; Dexheimer et al. 1985; Fortas and Chevalier 1990; 1992a, b; Roth-Bejareno et al. 1990; Cano et al. 1991; Kagan-Zur et al. 1994; Morte et al. 1994; 1995; Morte and Honrubia 1997). Species reported are the following: *Helianthemum tuberaria*, *H. guttatum* (L. Foureau), *H. salicifolium* (L). Mill., *H. ledifolium* (L). Mill., *H. salicifolium*, *H. almeriense,* and *H. sessiliflorum*.

The most common method of harvesting desert truffles is by observing the ground as it is often swollen and cracked at the base of the host plant.

In this chapter, we will include species recorded or collected by us in the countries of North Africa and give their geographical distribution.

10.2 The Species and Their Distribution

10.2.1 The Genus Delastria *(Tul. and C. Tul. 1843) Terfeziaceae (Montecchi and Lazzari 1993)*

10.2.1.1 *Delastria rosea* Tulasne 1843 (Figs. 10.1a, 10.2a, 10.3a, b)

(syn. *Terfezia rosea* (Tul.) Torrend 1907)

In Morocco, it is locally known as "bitter Terfass of pine." We harvest this species under pine (*Pinus pinaster* var. *atlantica*) on acid soils and under semiarid climate in the Mamora forest and in the green belt of Temara (near Rabat) the same places as *Tuber oligospermum* (Khabar et al. 2001), but it was also reported in Larache (Malençon 1973). Little buried, mature ascocarps are often exposed by the December rains. The harvest period is very short, from November to December. Little appreciated because of its bitter taste and unpleasant smell.

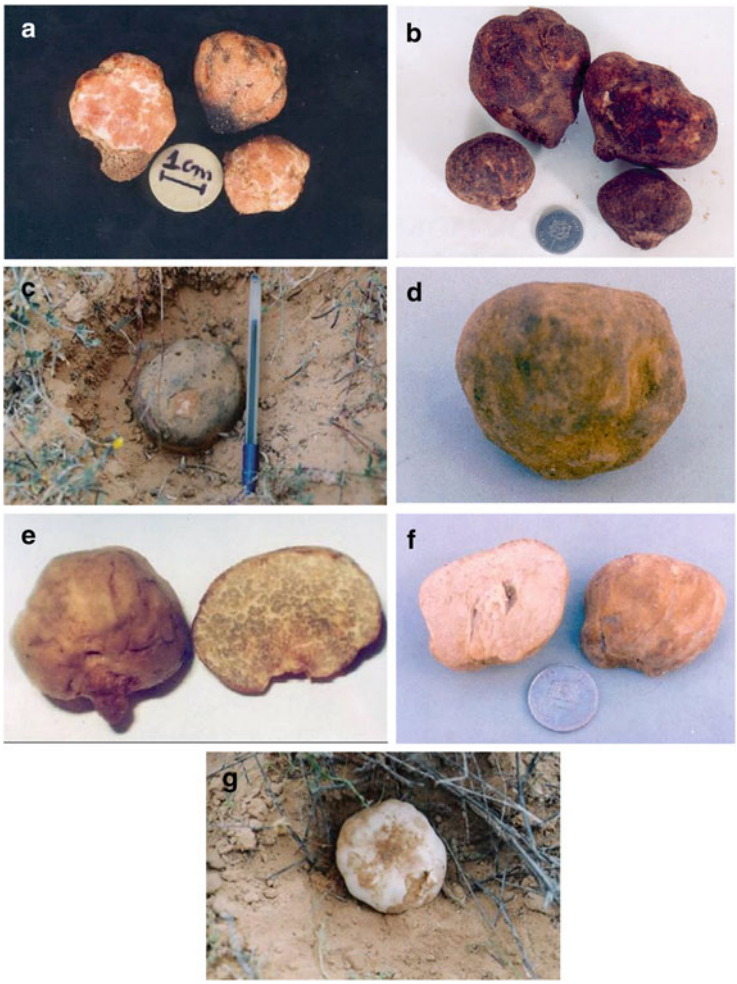

Fig. 10.1 Ascocarps of *Delastria rosea* (**a**), *Terfezia arenaria* (**b**), *T. boudieri* (**c**), *T. claveryi* (**d**), *T. leptoderma* (**e**), *Tirmania pinoyi* (**f**), and *T. nivea* (**g**)

10.2.2 The Genus Terfezia *(Tul. and C. Tul. 1851) Terfeziaceae (Montecchi and Lazzari 1993)*

10.2.2.1 *Terfezia arenaria* Trappe 1971 (Figs. 10.1b, 10.2b–d, 10.3c)

(syn. *Tuber arenarium* Moris 1829; *Terfezia leonis* Tul. 1851)

This species is very common in the countries of northern Africa. Generally, *Terfezia arenaria* is collected on acid soil in semiarid climate, under *Helianthemum guttatum*, as of the first week of March until May. It is highly prized by farmers, is

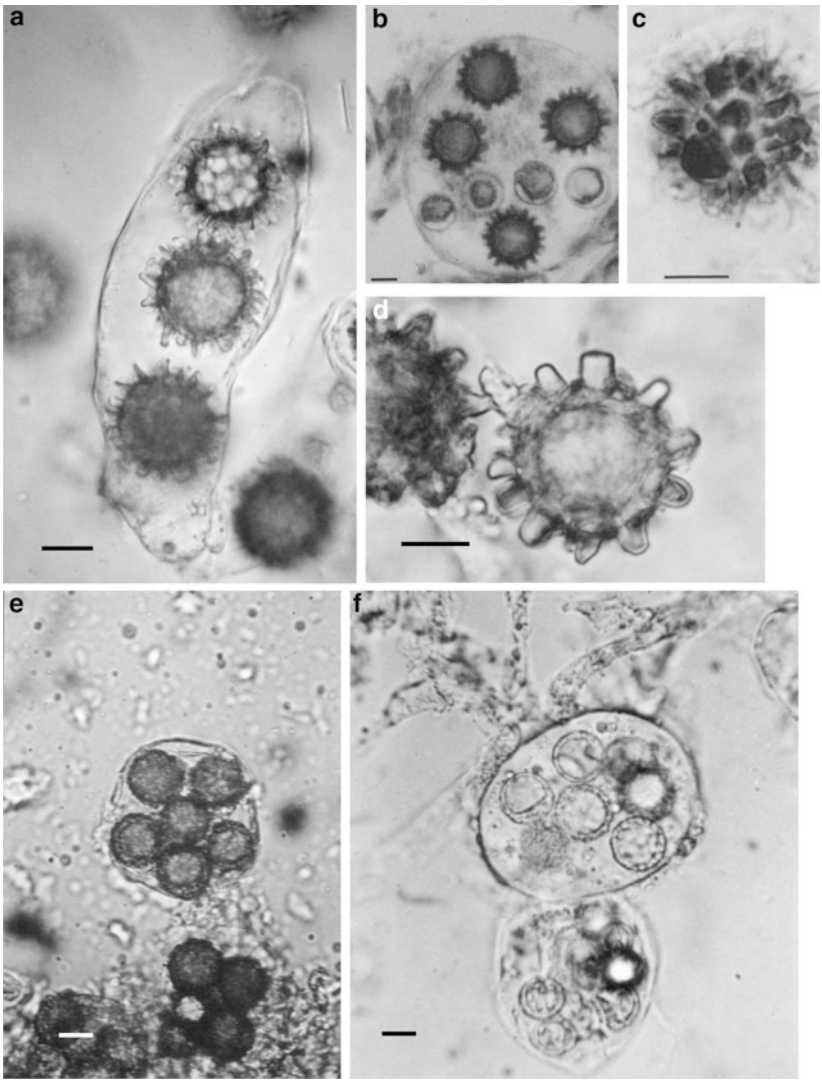

Fig. 10.2 (continued)

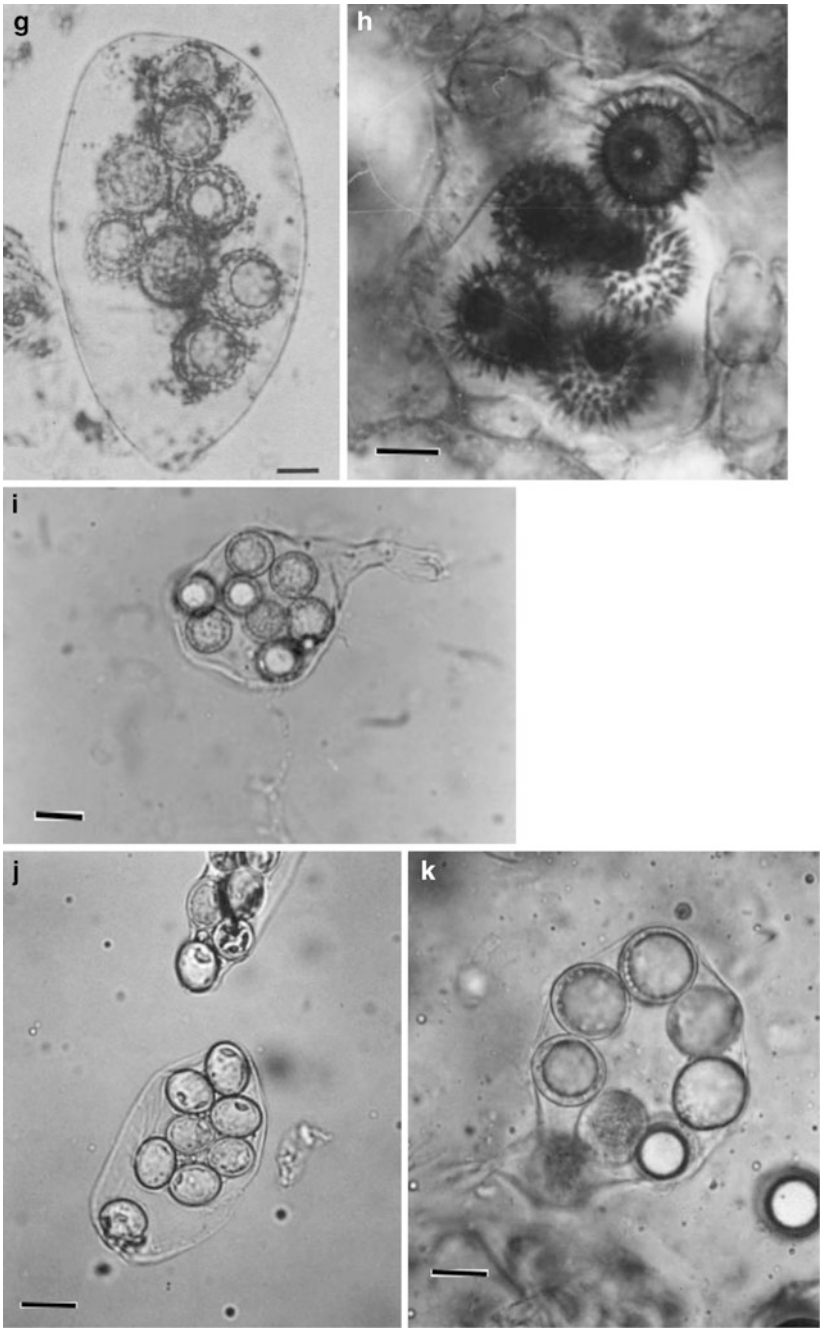

Fig. 10.2 Asci and ascospores (scale 10 μm); *Delastria rosea* (**a**); *Terfezia arenaria* (**b**–**d**); *T. boudieri* (**e**); *T. claveryi* (**f**); *T. leptoderma* (**g**, **h**); *Tirmania pinoyi* (**i**); *T. nivea* (**j**); and *Picoa juniperi* (**k**)

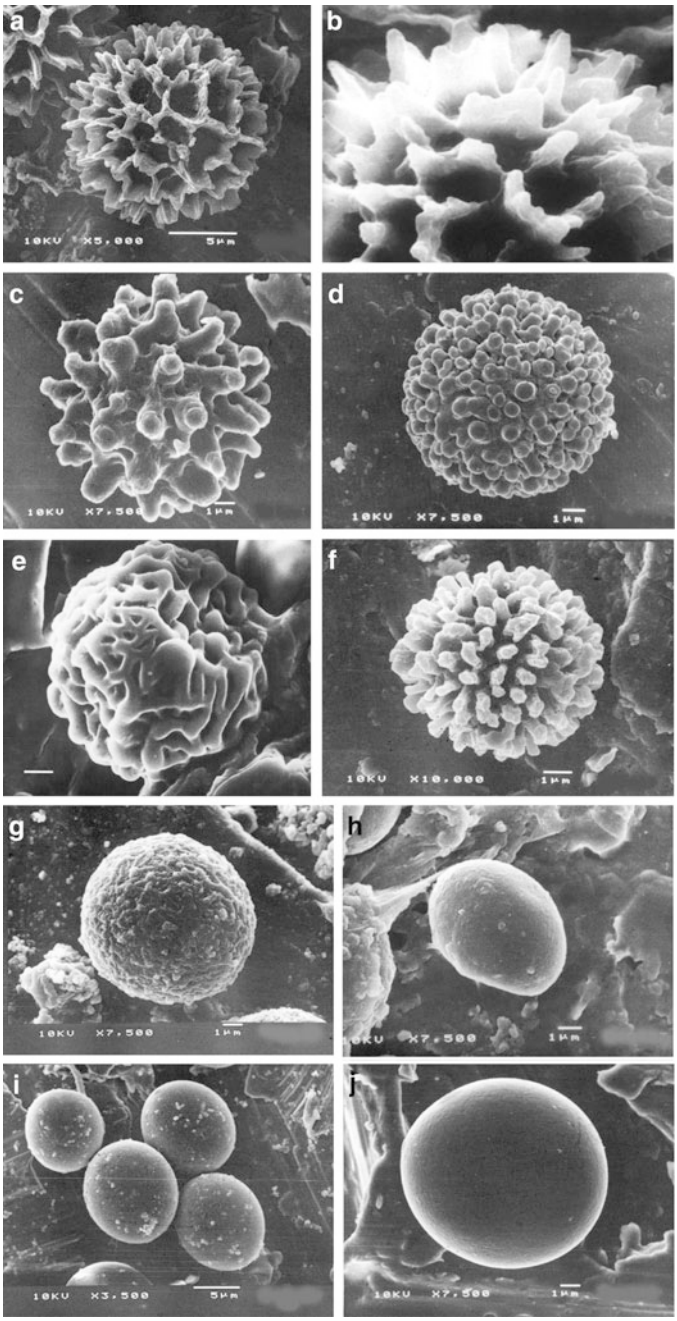

Fig. 10.3 Ascospores in scanning electron microscopy (SEM); *Delastria rosea* (**a**, b—detail); *Terfezia arenaria* (**c**); *T. boudieri* (**d**); *T. claveryi* (**e**); *T. leptoderma* (**f**); *Tirmania pinoyi* (**g**); *T. nivea* (**h**); and *Picoa juniperi* (**i**, **j**)

traded in local markets, and is even exported to Kuwait, to Saudi Arabia, and to Eastern countries generally (Khabar et al. 2001).

Distribution

In Algeria: this species is cited as being collected at Bou-Saada; Zeriguet by Fortas and Chevalier (1992a).

In Libya: at Misrata in Tripoli in the northwest of Libya (Chatin 1896a) in typically Mediterranean climate: hot and dry summers, cool winters, and some modest rainfall.

In Morocco: at the Moroccan Meseta between Rabat and Tangier (Malençon 1973); Mamora forest (Khabar et al. 2001)

In Tunisia: at Carthage (Patouillard 1894a, b). This fungus also grows in parts of the Northwest; Tabarka and Ain Draham (Khabar et al. 2005).

10.2.2.2 *Terfezia boudieri* Chat. 1891

(syn. *T. boudieri* var. *arabica* Chat. 1892; *T. deflersii* Pat. 1894) (Figs. 10.1c, 10.2e, 10.3d)

More southern than T. *arenaria*.

This species is harvested under *Helianthemum* spp., in desert plains (with arid to semiarid climate) of North Africa, in spring (March–April), generally on limestone soil.

Distribution

In Algeria: this species has been reported in southern Algeria (Biskra, Barika, Batna, Bou-Saada, and El Golea) by Chatin (1891a, b).

In Tunisia: this species is harvested from the second half of February throughout southern Tunisia, including Medenine, Tataouine, and Gafsa. It is called locally red terfez. It is widespread in arid areas and harvested under *Helianthemum lipii* or *H. sessiliflorum* and sometimes under *Rhanterium suaveolens* (Khabar et al. 2005; Slama et al. 2006).

In Morocco: this species is harvested at Had Hrara, region of Oualidia, about ten miles east of Safi area on the plain of Abda, not far from the Atlantic coast, also in Ain Beni Mathar, (region of Erfoud), on plateau of eastern Morocco and in southeast of Morocco. It is widespread in arid and calcareous soil under *Helianthemum sessiliflorum* and *H. ledifolium* (Khabar et al. 2001, 2005).

In Libya: this species has been reported by El-Kholy and Assim (1991).

In Egypt: this species has been reported by Ali et al. (1998) to grow both at the east and west of the Nile. Fruit bodies were also collected from the northwestern and northeastern parts of the Egyptian desert by Moawad et al. (1997) and were

reported from the northwestern coast of Egyptian desert including northern coast of North Sinai, Sidi Barrani, and Sallum (El-Kholy and Assim 1991; El-Kholy et al. 1992a, b; Pacioni and El-Kholy 1994).

10.2.2.3 *Terfezia claveryi* Chat. 1891

(syn. *T. hafizi* Chat. 1892) (Figs. 10.1d, 10.2f, 10.3e)

This species is very common in the semidesert plains of southern Mediterranean. It is widespread in sandy soils and limestone in arid and sub-Saharan regions. It is harvested under several species of *Helianthemum*: perennial, annual, herbaceous, or hemicryptophytes.

Distribution

In Algeria: at Laghouat oasis, 380 km south of Biskra (Chatin 1891a, b).

In Tunisia: this species is harvested in Dbin, the region of Tozeur, from mid-February on slightly sandy soils (khabar et al. 2005; Slama et al. 2006).

In Morocco: reported along the parallel 32° North, near the centers of Ksar-es-Souk, Bou-Bernous, Boudenib, and Figuig by Malençon (1973); also collected in calcareous soil, arid, and Saharan regions, at Ain Beni Mathar, Tendrara, Bouarfa, and region of Erfoud, in southeastern Morocco (Khabar et al. 2001, 2005). *T. claveryi* is collected in the proximity of *Helianthemum lipii* and *H. apertum* and sold under the name "red Terfass of Tafilalet." Very common, especially after heavy March rains. Highly sought after, it is the subject of major commercial activity in the east of Morocco between March and May (Khabar et al. 2001).

In Libya: cited by El-Kholy and Assim (1991).

In Egypt: collected from the northwestern and northeastern parts of the Egyptian desert (Moawad et al. 1997; El-Kholy and Assim 1991; Pacioni and El-Kholy 1994).

10.2.2.4 *Terfezia leptoderma* Tul. 1851

(syn. *Terfezia olbiensis* Tul. 1851 The *Terfezia olbiensis* Tul. Cited by several authors (Chatin 1891a, b; Ceruti 1960; Mattirolo 1905) was regarded as an immature form of *T. leptoderma* (Malençon cited by Moreno et al. 1986). New research has restated *T. olbiensis* as a distinct independent species (see Chap. 3 by Bordallo and Rodríguez).

(syn. *Choiromyces leptodermus* Tul. 1845; *Terfezia fanfanii* Matt. 1900) (Figs. 10.1e, 10.2g, h, 10.3f)

Distribution

We collect *T. leptoderma* in the Mamora forest on acid soil under *Helianthemum guttatum* from the third week of February until May. We also collected it under pine (*Pinus pinaster* var. *atlantica*) from November to January. Often sold mixed with *Terfezia arenaria*. It is considered by farmers as an indicator of the arrival of the "real" Terfess (*Terfezia arenaria*) (Khabar et al. 2001).

10.2.3 The Genus Tirmania *(Chat. 1891)*

Species of the genus *Tirmania* are locally known as "white Terfass of Tafilalet" or "Zubaidi." They are very abundant at calcareous soils of desert areas in arid, sub-Saharan, and Saharan regions. They are harvested under *Helianthemum* spp. such as *Helianthemum hirtum*, *H. lipii*, *H. ledifolium*, *H. salicifolium* at the second week of December until the end of March.

Two species are known *Tirmania* to date.

10.2.3.1 *Tirmania pinoyi* (Maire) Malençon 1973 (syn. *Terfezia pinoyi* Maire 1906) (Figs. 10.1f, 10.2i, 10.3g) and *Tirmania nivea* (Desf. Ex. Fr.) Trappe 1971 (syn. *Tuber niveum* Desf. ex Fr. 1823; *Terfezia ovalispora* Patouillard 1890; *Tirmania ovalispora* (Pat.) Pat. 1892; *Tirmania africana* Chatin 1892; *Terfezia africana* (Chat.) Maire 1916; *Tirmania camboni* Chatin 1892) (Figs. 10.1g, 10.2j, 10.3h)

Distribution

In Algeria: cited at Biskra, Batna, and Barika (Chatin 1891a, b) and at Zériguet and west of Naama (Fortas and Chevalier 1992a, b.

In Morocco: very abundant in the southeast of Morocco; in the high plateau of eastern Morocco; and regions of Ain Beni Mathar, Bou-Bernous, Tendrara, Bouarfa, Erfoud, Figuig, and Rissani (Khabar et al. 2001). Also reported at the Hamada Daoura, southern Morocco, 29°N latitude by Malençon (1973). These species have been collected in calcareous soil, arid, and Saharan regions under *Helianthemum hirtum*, from the second week of December until the end of March (Khabar et al. 2001).

In Tunisia: the species of this genus are very common at Ben Gardane, Tataouine, and Gafsa in southern Tunisia. They grow near *Helianthemum lipii* and are harvested in the month of February (Khabar et al. 2005; Slama et al. 2006).

In Libya: (El-Kholy and Assim 1991).

In Egypt: collected from the northwestern and northeastern parts of the Egyptian desert (Moawad et al. 1997; El-Kholy and Assim 1991 and Pacioni and El-Kholy 1994).

10.2.4 The Genus Picoa *(Vitt. 1831)*

10.2.4.1 *Picoa juniperi* Vitt. 1831 (syn. *Picoa juniperina Tul. 1851)* (Figs. 10.2k, 10.3i, j)

In Morocco, locally called "Ed doukar," this species is very rare; it is harvested with *Terfezia claveryi* under *Helianthemum lipii* at the end of February (Khabar et al. 2001, 2005)

In Tunisia: this species is harvested in the region of Tozeur and Gafsa to the second half of February near *Rhanterium suaveolens* and *Helianthemum lipii* (Khabar et al. 2005; Slama et al. 2006).

10.2.4.2 *Picoa carthusiana* Tul. and C. Tul. 1851

In Tunisia: this species is called "zouber." It is harvested in the region of Tozeur and Gafsa to the second half of February near *Rhanterium suaveolens* and *Helianthemum lipii*. It is considered as indicator of sites *Terfezia* and *Tirmania* (Khabar et al. 2005; Slama et al. 2006).

In Egypt: collected by Pacioni and El-kholy (1994).

10.3 Comparisons and Conclusions

We note that the countries of northern Africa (Morocco, Algeria, Tunisia, Libya, and Egypt) have a high species diversity of desert truffles, and there are a dozen species distributed more or less throughout large areas with a specific distribution depending on the nature of the soil and climate. We note both analogies with other Mediterranean countries and those of Middle Eastern Asia. Thus the species recorded in other Mediterranean countries, Spain, southern France, and southern Italy (*Terfezia arenaria*, *T. leptoderma*) are found in the north where the climate is semiarid. By contrast, species which are rather xerothermophilous (*Terfezia claveryi*, *T. boudieri*, *Tirmania pinoyi,* and *T. nivea*) are harvested in the south where the climate is arid and relatively sub-Saharan. These species are encountered in some countries of East Asia (Kuwait, Saudi Arabia, Israel, Turkey, Iraq, Syria) (Chatin 1891a; b; Dickson 1955; Awameh et al. 1979, see also Chaps. 12, 9 and 11 by Ammarellou et al., Chevalier and Kagan-Zur and Akyuz). We also find that some species, *Terfezia leptoderma* and *T. arenaria*, prefer acidic soils while

Terfezia boudieri, *T. claveryi*, *Picoa juniperi* and *P. carthusiana*, *Tirmania pinoyi* and *T. nivea*, which are species xerothermophilous, prefer rather alkaline soils (limestone). Finally, both our observations and the consulted bibliographies confirmed the characteristic distribution of truffle species between Europe and North Africa, as claimed by Malençon (1973). So, these are the truffles of the genus *Tuber* dominate in humid and subhumid countries of Europe, while the genera *Tirmania* (*T. pinoyi* and *T. nivea*), Picoa (*P. juniper* and *P. carthusiana*), and *Terfezia* (*Terfezia claveryi* and *T. boudieri*) characterize arid and Saharan countries of the southern Mediterranean.

However, few species of *Terfezia* (*T. arenaria*, *T. leptoderma,* and *Delastria rosea*) are common to both southern European and North African countries.

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