**PHELLINUS HIPPOPHAËICOLA (HYMENOCHAETACEAE) IS NOT RARE IN POLAND: FINDINGS FROM THE POBRZEŻE SZCZECIŃSKIE COASTLAND**

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**Abstract.** The occurrence of *Phellinus hippophaëicola* H. Jahn, a fungal pathogen of *Hippophaë rhamnoides* L., on the Pobrzeże Szczecińskie coastland, NW Poland, was surveyed during 2015–2016. Altogether 59 localities of *Phellinus hippophaëicola* were recorded, including the first Polish inland localities on cultivated plants of *Hippophaë rhamnoides*. The localities are from 18 ATPOL grid squares, including 43 localities on the Baltic Sea coast. *Phellinus hippophaëicola* occurred at 74% of all the localities of *Hippophaë rhamnoides* examined, and at ca 84% of the plant’s natural sites. These findings, and also the status of *Hippophaë rhamnoides* as a protected species occurring in protected habitats in Natura 2000 sites, mean that *Phellinus hippophaëicola* is not a rare and endangered species in Poland. In total, 69 localities located in 28 ATPOL grid squares, including the localities reported here, are currently known from Poland.

**Key words:** distribution, *Elaeagnus angustifolia*, *Hippophaë rhamnoides*, *Phellinus hippophaëicola*, Pobrzeże Szczecińskie coastland, Poland

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**INTRODUCTION**

The basidiomycete fungus *Phellinus hippophaëicola* H. Jahn belongs to the diverse genus *Phellinus* s.l. classified within the order Hymenochaetales and family Hymenochaetaceae (Robert et al. 2005). It is a parasite and a causal agent of white rot of *Hippophaë rhamnoides* L. (rarely *Elaeagnus angustifolia* L.), though less frequently it also lives as a saprotroph. The fruitbodies of the fungus appear on trunks and branches (Jahn 1976). *Phellinus hippophaëicola* is widespread in Europe and eastwards towards Central Asia. Its range is closely related to that of *Hippophaë rhamnoides*; it occurs in all of its thickets with old shrubs (Jahn 1976). In Europe it is known from Great Britain (England, Scotland, Wales), France, Belgium, Holland, Denmark, Germany, Poland, Norway, Sweden, Finland, Lithuania, Switzerland, Austria, Italy, Bulgaria, Luxembourg, Turkey and the southern part of European Russia (Domański et al. 1967; Mazelaitis 1976; Michael et al. 1981; Breitenbach & Kränzlin 1986; Kreisel 1987, 2009; Krieglsteiner 1991, 2000; Ryvarden & Gilbertson 1994; Gricius & Matelis 1996; Niemelä 1997, 2001; Gyosheva et al. 2006; Sesli & Denchev 2009; Denchev & Assyov 2010; Ghobad-Nejhad 2011; Kunuttu et al. 2011; Garnier-Delcourt et al. 2013). In Asia it has been recorded in Russia (Western Siberia), Kazakhstan, Georgia, Azerbaijan, Uzbekistan, China, India and Thailand (Bondartsev 1953; Shvartsman 1964; Dai 2010, 2012; Chandrasrikul et al. 2011; Ghobad-Nejhad 2011; Ranadive et al. 2011; Vlasenko 2013).

In Poland, *Phellinus hippophaëicola* was rarely reported previously; 16 localities of this fungus were reported earlier, scattered exclusively along the coast of the Baltic Sea between the towns of Międzyzdroje and Krynica Morska (Wojewoda 2002, 2003; Wilga & Wantoch-Rekowski 2013). This study presents the results of detailed surveys of the occurrence of *Ph. hippophaëicola* on the Pobrzeże Szczecińskie coastland in northwest
Poland. Based on the newly acquired data, the current distribution and threat status of the fungus in Poland are discussed.

**Material and methods**

To examine the occurrence of *Phellinus hippophaëicola* on the Pobrzeże Szczecińskie coastland, localities of its hosts, *Hippophaë rhamnoides* and *Elaeagnus angustifolia*, were first identified. *Hippophaë rhamnoides* is a shrub which may be collected outside of dune and cliff habitats provided that the shrubs are not damaged. It was under full protection between 1983 and 2014, and its occurrence is registered in documentary publications and nature protection studies.

The data on the occurrence of *Hippophaë rhamnoides* on the Pobrzeże Szczecińskie coastland are based on the *Distribution Atlas of Vascular Plants in Poland* (Zając & Zając 2001), the distribution atlas of protected and endangered species of vascular plants in Zachodniopomorskie (West Pomerania) Province (Jasnowska et al. 2009), and my research. The data on *H. rhamnoides* sites specifying exact locations in the latter atlas proved especially useful. That information was based on nature inventories of local administrative units and nature reserve protection plans. Also invaluable were the resources of the Nature Conservation Agency in Szczecin from 1996–2009. My detailed survey of the occurrence of *Phellinus hippophaëicola* in 2015–2016 also includes the results of sporadic observations from 2003–2014 which I repeated in 2015–2016.

Localities of *Hippophaë rhamnoides* with known geographical coordinates were identified in the field using a GPS recorder. Areas for which there was no information about its occurrence were searched on foot. I also searched for *Elaeagnus angustifolia*, as there were no available data on its occurrence in the study area. After finding prospective host plants, their living and dead shoots were checked exhaustively to find fruitbodies of *Phellinus hippophaëicola*. The range of individual localities of *H. rhamnoides* and *E. angustifolia* as well as *Ph. hippophaëicola* was pinpointed using a GPS device and described with geographical coordinates. The survey includes general notes on the topography of the locality, the manner of shrub occurrence, vegetation accompanying *H. rhamnoides*, and the abundance of fruitbodies of *Ph. hippophaëicola*.

I attempted to establish exact figures for the number of fruitbodies of *Phellinus hippophaëicola* and the number of *Hippophaë rhamnoides* individuals infected by it, but in many cases had to estimate the numbers due to difficult field conditions. Vegetation patches on steep cliff walls were often inaccessible, dense thickets of thorny shrubs formed impenetrable barriers, and access to some areas was limited due to protection of the sea coastline and restrictions at military facilities and on private land.

A three-degree scale was used to describe the number of shrubs inhabited by fruitbodies of *Ph. hippophaëicola*, which could be treated as the number of individuals of *Ph. hippophaëicola* (1 – on 1 shrub, 2 – on 2–10 shrubs, 3 – on more than 10 shrubs). This scale does not include the number of fruitbodies on individual shrubs, which is related to mycelium maturity and host infection degree. There may have been more shrubs hosting *Ph. hippophaëicola* which could not be noted due to the obstacles described above. The localities are documented by photographs. The fruitbodies are deposited in the herbarium of the West Pomeranian University of Technology, Szczecin.

The study area is the Pobrzeże Szczecińskie coastland macroregion, which covers ca 8000 km² and is part of the Pobrzeże Południowobaltyckie coastland subprovince (Kondracki 2002). The search for localities of *Ph. hippophaëicola* was conducted mostly in two mesoregions (Użnam and Wolin, Wybrzeże Trzebiatowskie coast) along coastline stretching over 100 km but also at all the localities of *Hippophaë rhamnoides* and *Elaeagnus angustifolia* known previously or found in the present study inland in five mesoregions (Równina Wkrzańska plain, Wzgóra Szczecińskie hills, Wzgórzę Bukowe hills, Równina Pyrzycko-Stargardzka plain, Równina Nowogardzka plain). To complete the examination of square Bb–00, a small section of the Wybrzeże Slowińskie coast mesoregion in the Pobrzeże Koszaliński coastland macroregion was also investigated.

Localities of *Phellinus hippophaëicola* on *Hippophaë rhamnoides* growing individually or in small clusters were pinpointed with a GPS device exactly at the site of their occurrence. For *Ph. hippophaëicola* living on shrubs growing close to each other or within long linear localities of *H. rhamnoides*, the weighted center of the locality was considered a locality. If such field localities of *Ph. hippophaëicola* were up to 500 apart, they were merged for mapping purposes and treated as one locality.

I analyzed the occurrence of *Phellinus hippophaëicola* in relation to the distribution of its host, *Hippophaë rhamnoides*. The number of host localities confirmed in this study, taken as 100%, was used to examine the occurrence of the fungus in order to capture the actual distribution of both organisms.
The results are presented as a cartogram of ATPOL grid squares and an ATPOL grid topogram (Zając 1978) in the mycological modification by Wojewoda (2000). Mapping was automated using MapSource 6.13.7 and MapInfo Professional 6.5 SCP.

Results

A total of 59 localities of *Phellinus hippophaeicola* were recorded in the study. All numbered localities in 10×10 km squares are listed below in an east-west belt of ATPOL grid squares. The following information is given for each locality: name of macro- and mesoregion, nearest village, town or city, geographical coordinates, characteristic features of the locality of *Hippophaë rhamnoides*, abundance of *Phellinus hippophaeicola*, and observation date. The numbering of localities corresponds to the numbering in Figure 1.

**Ba–07 – POBREŻE SZCZEŚCIŃSKIE COASTLAND. Wybrzeże Trzebiatowskie coast**:

1 – vicinity of Śliwina, 54°05′22.668036″N, 15°02′23.531856″E, individual specimens of *Hippophaë rhamnoides* on edge of gentle cliff, 17 May 2014; 2 – Niechorze, 54°05′39.30018″N, 15°03′34.847928″E, *Hippophaë rhamnoides* of varying density on cliff slope and top along ca 500 m, 3, 19 Sept. 2007, 4 Apr. 2010, 17 May 2014; 3 – Niechorze, 54°05′44.375856″N, 15°04′04.835712″E, *Hippophaë rhamnoides* shrubs and trees scattered in thick thickets overgrowing tall cliff along ca 400 m directly neighboring locality no. 2, 3, 19 Sept. 2007, 4 Apr. 2010, 17 May 2014.
Ba–08 – Pobrzeże Szczecińskie coastland, Wybrzeże Trzebiatowskie coast: 4 – Mrzeżyno, 54°08′50.028″N, 15°17′27.599712″E, probably a locality reported by Wojewoda (2002), spaced clusters of Hippophaë rhamnoides shrubs near Elaeagnus angustifolia and Rosa rugosa on edge of tall cliff, on margin of coniferous forest, 1, 18 May 2015.

Bb–00 – Pobrzeże Szczecińskie coastland, Wybrzeże Trzebiatowskie coast: 5 – Kołobrzeg, 54°10′39.036″N, 15°32′01.032072″E, cluster of ample Hippophaë rhamnoides over low dune cliff, 2, 13 Feb. 2016; 6 – Kołobrzeg, 54°10′44.760036″N, 15°32′16.583928″E, thickets of Hippophaë rhamnoides and Rosa rugosa over low dune cliff, 2, 13 Feb. 2016; 7 – Kołobrzeg, 54°10′58.36152″N, 15°32′42.30024°E, individual specimens of Hippophaë rhamnoides along 100 m section on low dune cliff secured by boulders, 2, 13 Feb. 2016; Pobrzeże Koszalińskie coastland, Wybrzeże Słowińskie coast: 3 – Kołobrzeg, by pier, 54°11′11.400144″N, 15°33′43.811892″E, locality probably a locality reported by Wojewoda (2002), spaced clusters of Hippophaë rhamnoides and Rosa rugosa over edge of tall cliff, on margin of coniferous forest, 1, 18 May 2015; 4 – Mrzeżyno, 54°11′25.57968″N, 15°36′24.105132″E, escarpment of grey dune overgrown with Rosa rugosa, Pinus sylvestris, Caragana arborescens, Acer platanoides, Cornus mas), 3, 11 May 2015; 5 – Dziwnów, 54°01′33.672036″N, 14°44′58.919532″E, vegetation similar to that at adjacent locality no. 14, 2, 11 May 2015; 6 – Dziwnów, 54°01′53.321592″N, 14°46′22.850868″E, dense Hippophaë rhamnoides thickets among Rosa rugosa and Salix daphnoides, on grey dune along 500 m section, buried by sand in many places, 3, 11 May 2015; 7 – Dziwnów, 54°02′11.328036″N, 14°47′53.447388″E, Hippophaë rhamnoides thickets with Salix daphnoides on escarpment of grey dune on margin of coniferous forest, along ca 400 m section, 3, 11 May 2015; 8 – Łukęcin, 54°02′58.226604″N, 14°52′00.368832″E, thickets of Hippophaë rhamnoides of varying density on slope and top of cliff crumbling in some places, along ca 300 m section, 2, 11 May 2015.

Ba–16 – Pobrzeże Szczecińskie coastland, Wybrzeże Trzebiatowskie coast: 19 – Łukęcin, 54°03′08.603892″N, 14°53′09.81582″E, Hippophaë rhamnoides thickets of varying density on slope of overgrowing and crumbling tall cliff and along its edge on forest margin, along ca 300 m section, 2, 11 May 2015; 20 – Łukęcin, 54°03′13.032144″N, 14°53′38.975568″E, Hippophaë rhamnoides thickets on entire slope of tall cliff, 2, 11 May 2015; 21 – Pobierowo, 54°03′34.380108″N, 14°55′16.283586″E, probably this is locality no. 21 or no. 22 as reported by Wojewoda (2002), thickets of Hippophaë rhamnoides on slope of overgrown dead cliff (Sorbus aucuparia, Betula pendula, Populus tremula, Viburum opulus, Salix caprea), covered by sand at bottom, along ca 400 m section, 2, 6 June 2015; 22 – Pobierowo, 54°03′45.33822″N, 14°56′03.556212″E, clusters of Hippophaë rhamnoides on tall grey tune reinforced with boulders, 2, 6 June 2015; 23 – Pustkowo, 54°04′14.508228″N, 14°58′03.04932″E, probably a locality reported by Wojewoda (2002), scattered shrubs of Hippophaë rhamnoides on tall edge, 2, 6 June 2015; 24 – Trzęsacz, 54°04′40.115982″N, 14°59′35.339748″E, larger and smaller Hippophaë rhamnoides thickets on slope and top of cliff of varying height, along ca 500 m section, 2, 6 June 2015; 25 – Rewal, 54°05′06.36″N, 15°01′22.943856″E, trimmed shrubs in Hippophaë rhamnoides thickets on developed cliff beneath viewing deck, 2, 17 May 2014.


Ba–21 – Pobrzeże Szczecińskie coastland,


Ba–25 – POBRYZHYE SZCZECINSKI COASTLAND, Wybrzeże Trzebiatowskie coast: 47 – Buniewice (Wyspa Chrząszczewska), 53°58’46.091964″N, 14°43’47.207532″E, small cluster of *Hippophaë rhamnoides* among thickets of *Crataegus monogyna*, *Rosa canina* and *Sambucus nigra*, on tall edge of Zalew Kamięński lagoon neighboring with meadow communities, 1, 10 June 2015.

Ba–31 – POBRYZHYE SZCZECINSKI COASTLAND, Uznam and Wolin: 48 – Karsibór, Półwysep Melinka peninsula on Stara Świna River, 53°51’23.219928″N, 14°17’06.395208″E, thickets of *Hippophaë rhamnoides* on top of cliff, 2, 20 Apr. 2015; 49 – Wolin National Park, Półwysep Mielinek, on tall edge of Zalew Sambuska River, 53°58’21.452208″N, 14°17’22.163304″E, individual thickets of *Hippophaë rhamnoides* spreading onto xerothermic grassland, along Mostowa Street along ca 100 m section, 2, 10 June 2015; 50 – Karsibór, 53°58’40.643964″N, 14°17’22.163304″E, *Hippophaë rhamnoides* thickets on fringe of riparian willow forest, spreading onto xerothermic grassland, along Mostowa Street along ca 100 m section, 2, 10 June 2015; 51 – Lubin, 53°51’50.430708″N, 14°25’51.400704″E,
Hippophaë rhamnoides shrubs among thickets of Rosa canina, Prunus spinosa, Crataegus monogyna and Corylus avellana, on steep cliff on Zalew Szczeciński lagoon, 2, 13 Apr. 2015.

Ba–33 – Pobrzeże Szczecińskie coastline, Uznam and Wolin: 52 – Wapnica, 53°52′42.361392″N, 14°26′26.43666″E, probably a locality reported by Wojewoda (2002), pruned Hippophaë rhamnoides thickets among thickets of Rosa canina, Prunus spinosa and Crataegus monogyna, on escarpment on northern shore of Jezioro Turkusowe lake, along ca 300 m section, 3, 13 Apr. 2015.

Ba–73 – Pobrzeże Szczecińskie coastline, Wzgóra Szczecińskie hills: 53 – Szczecin, Przyjaciół Żołnierza Street, 53°27′17.85892″N, 14°33′17.099604″E, on shrubs of Hippophaë rhamnoides planted on south-facing escarpment (anthropogenic locality), 2, 28 March 2015; 54 – Szczecin, Ofiar Oświęcimia Street, 53°26′35.285568″N, 14°33′19.45638″E, on shrubs and small trees of Hippophaë rhamnoides planted on small escarpment along pavement (anthropogenic locality), 2, 25 July 2015.

Ba–83 – Pobrzeże Szczecińskie coastline, Wzgóra Szczecińskie hills: 55 – Szczecin, Południowa Street by Rondo Uniwersyteckie traffic circle, 53°24′15.649884″N, 14°30′06.889176″E, thick shrub plantation of Hippophaë rhamnoides planted on lawn along street on ca 50 m section (anthropogenic locality), 2, 26 Aug. 2015; Wzgóra Bukowe hills: 56 – Szczecin, Morwowa Street, 53°21′51.410052″N, 14°36′39.179556″E, cluster of Hippophaë rhamnoides shrubs along side of street (anthropogenic locality), 1, 26 Aug. 2015.

Ba–96 – Pobrzeże Szczecińskie coastline, Równina Pyrzycko-Stargardzka plain: 57 – Stargard, Spokojna Street, 53°19′42.492″N, 15°00′52.127856″E, three shrubs of Hippophaë rhamnoides within allotments, among tall herb vegetation of Calamagrostis epigeios, Agropyron repens, Urtica dioica, Solidago canadensis and Phalaris arundinacea (anthropogenic locality), 2, 8 July 2015; 58 – Stargard, Św. Jana Chrzciciela Street near Plac Wolności square, 53°20′21.984072″N, 15°02′16.58364″E, three trees of Hippophaë rhamnoides on margin of Bolesław Chrobry Park (anthropogenic locality), 2, 8 July 2015.

Ba–97 – Pobrzeże Szczecińskie coastline, Równina Nowogardzka plain: 59 – Kiczarowo, near Ozy Kiczarowskie Reserve, 53°21′34.883856″N, 15°06′07.595712″E, cluster of Hippophaë rhamnoides shrubs and trees in vicinity of Prunus spinosa and Sambucus nigra on margin of tree plantation along road, 3, 22 July 2015.

Discussion

A total of 142 localities of Hippophaë rhamnoides in the Pobrzeże Szczecińskie coastline are reported in the distribution atlas of protected and endangered vascular species in West Pomerania Province (Jasnowska et al. 2009). When 500 m was taken as the size of localities for my present study, the number of localities decreased by 120. Using a GPS device, 64 of these localities were sought. Twenty-five of them were discovered; the other 39 were not found despite searching at least within a 100 m radius of the reported site. Conditions for the occurrence of H. rhamnoides were not observed at many of these sites, suggesting that not all the data derived from nature inventories of administrative districts are reliable.

I also applied the route method to look for new localities of H. rhamnoides, especially in areas where data were not provided and the known localities were more than 2 km distant from each other. In total, a section stretching over 50 km of coastline was thoroughly penetrated, yielding 55 newly identified localities of H. rhamnoides. The entire accessible coastline along ca 8 km was thoroughly investigated in square Ba–09, but H. rhamnoides was not found there.

The investigations covered 16 contiguous ATPOL grid squares along the coastline and eleven scattered localities inland. Hippophaë rhamnoides was found in 21 squares at a total of 80 localities. Twenty-one of the 80 localities should be treated as anthropogenic, where the species was planted for ornamental purposes or to reinforce escarpments. These results were used to examine the spread of Phellinus hippophaëicola parasitizing Hippophaë rhamnoides. Phellinus hippophaëicola was observed in 18 squares at a total of 59 merged 500 m localities, that is, 113 field localities. It was not observed in only three squares where H. rhamnoides occurred (Ba–46, Ba–53, Ba–84). An analysis of the occurrence of Ph. hippophaëicola relative to the distribution of its host shows that Ph. hippophaëicola occurred at ca 74% of the studied localities of H. rhamnoides. As many as ca 85% of the Ph. hippophaëicola localities were noted at natural sites of H. rhamnoides, but at only ca 43% of the anthrop-
pogenic sites. I observed signs of shrub cutting for maintenance and sanitation at anthropogenic sites in the towns of Szczecin, Stargard and Świnoujście; maintenance measures may have included removal of infected shrubs or parts of them containing *Phellinus hippophaëicola* fruitbodies. Anthropogenic localities in Szczecin and Stargard, situated in grid squares Ba–73, Ba–83 and Ba–84 at distances of 52 and 78 km from the Baltic Sea shore, are the first inland observations of *Ph. hippophaëicola*. The synanthropic occurrence of *Ph. hippophaëicola* in botanical gardens has been referred to by other authors including Kreisel (1979) in Greifswald and Bresinsky and Besl (1999) in northern Bavaria.

An analysis of the occurrence of *Phellinus hippophaëicola* only along the Baltic coastline shows a total of 43 localities, one locality per 2.3 km section of the coastline on average. The density of localities was greatest on Uznam Island (square Ba–21), where seven consecutively contiguous localities were noted along a 3.5 km long section. *Hippophaë rhamnoides* infected by *Ph. hippophaëicola* occurs in this area as a belt up to 150 m long. This large locality continues beyond Poland’s western border (my observations). Larger gaps in the continuity of the spread of *Ph. hippophaëicola* can be seen in the eastern section of the Pobrzeże Szczecińskie coastland in squares Ba–07, Ba–08 and Ba–09. Localities 3, 4 and 5 are ca 16 km distant from each other.

*Phellinus hippophaëicola* was not found on *Elaeagnus angustifolia* in field searches.

Fig. 2. Distribution of *Phellinus hippophaëicola* H. Jahn in Poland.
Elaeagnus angustifolia was observed in seven squares (Ba–07, Ba–08, Ba–15, Ba–22, Ba–73, Ba–83, Ba–96) and at 14 localities, including four localities (4, 14, 15, 34) where it co-occurred with Hippophaê rhamnoides. Jahn (1976) reported Ph. hippophaëicola on E. angustifolia but the site location was not specified. Elaeagnus angustifolia as a host of Ph. hippophaëicola is reported in keys and atlases (Jülich 1984; Breitenbach & Kränzlin 1986; Ryvarden & Gilbertson 1994; Wojewoda 2002, 2003; Bernicchia 2005). In the available literature I found only one report of the occurrence of Ph. hippophaëicola on E. angustifolia in Sichuan Province in central China (Dai 2010).

Together with the new localities described in this study, a total of 69 localities in 28 10 × 10 km ATPOL grid squares are known from Poland (Fig. 2). The six sites reported by Wojewoda (2002) for the Pobrzeże Szczecińskie coastland seem to have been confirmed in this study, as the locations given in those records were only approximate and their descriptions are similar to the present records.

Due to the number of the localities of the fungus and their high occurrence at the localities of Hippophaê rhamnoides, Phellinus hippophaëicola seems to be a common species on the Pobrzeże Szczecińskie coastland, and not endangered. The same may hold true for the remaining coastal area of Poland. Its localities are indirectly covered by partial protection of H. rhamnoides, which it parasitizes, and by their status as Natura 2000 sites (vegetated sea cliffs – 1230, sea dunes with H. rhamnoides – 2160) where localities of H. rhamnoides occur naturally (Council Directive 92/43/EEC of 21 May 1992).

The Phellinus hippophaëicola fruitbodies observed in this study fully agreed with the morphological and microscopic features given in the species description (Jahn 1976) as well as in keys and atlases. White webs of insect larvae were often seen on the fruitbodies. The development of Lepidoptera larvae of Morophaga chloragella D. & Sch. and Scardia tessulatella Z. in fruitbodies of Phellinus hippophaëicola has been reported (Burmann 1983). Morophaga chloragella is a frequent insect whose development takes place in fruitbodies of many other wood-inhabiting fungi such as Bjerkandera adusta (Willd.) P. Karst., Ganoderma applanatum (Pers.) Pat., Phellinus robustus (P. Karst.) Bourdot & Galzin and Trametes gibbosa (Pers.) Fr. (Jaworski et al. 2011). Algae belonging to Chlorophyta (Chlorococcum sp.) develop on the upper surface of old fruitbodies (Dr. W. Kowalski, pers. comm.).

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