

A close-up photograph of the plant Xanthocyparis vietnamensis. The image shows several green, needle-like branches with a distinct diamond-shaped pattern on the needles. In the center, there are two brown, woody cones with a scaly, textured surface. The background is a soft-focus green, suggesting more of the plant's foliage.

ASSESSMENT
of
XANTHOCYPARIS VIETNAMENSIS



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Assessment of *Xanthocyparis vietnamensis* nature protected status in Tuyen Quang province

SHORT PRELIMINARY REPORT

Investigations, studies and assessments of newly discovered populations of tertiary relict, critically endangered, strict Vietnamese endemic – Golden Cypress (*Xanthocyparis vietnamensis*, Cupressaceae) supported financially from Rufford Small Grant Found were fulfilled during year 2013.

Current investigation provides original data of field assessment of distribution, habitat conditions and conservation status of newly discovered populations of critically endangered tertiary relict conifer – *Xanthocyparis vietnamensis* (Golden Cypress) for elaboration and improving strategy for its protection. This taxonomically very isolated monotype genus represents strict local endemism of rocky limestone areas of northern Vietnam was known before only by 4 small highly endangered and depleted populations. Current study presents schematic description of primary vegetation, natural conditions, square and size of 6 newly discovered populations, as well as provides basic recommendations for their effective protection to conserve of genetic diversity of this unique species.

Golden Cypress (*Xanthocyparis vietnamensis*) was discovered in northern Vietnam by N.T.Hiep and L.Averyanov in 1999 on rocky limestone of Bat Dai Son Mountains (Averyanov et al., 2002) near the border with China. It was recognized as alone species of new relict monotype conifer genus with closest relative – genus *Callitropsis* spreading in northern America (Farjon et al., 2002; Farjon, 2010). The plant was one of the most remarkable discoveries in plant taxonomy of last decades (Farjon, 2010). Meanwhile, alone population found at that time in northern part of Ha Giang Province (with 3 subpopulations in Bat Dai Son mountains, Sinh Lung and Ho Quang Phin communes) was endangered and highly depleted, why species status was reasonably estimated as globally critically endangered (N.T.Hiep, 2004; Regalado et al., 2006). Some year later miserable population consisting of few depressed mature trees were additionally found in Bac Me (Ha Giang Province). Additionally, important, but still questionable data (not verified by any collections) about species occurrence come from in Bao Lam, Bao Lac and Thach An Districts (Cao Bang Province). Largest population, discovered by Center for Plant Conservation (CPC) on September 2011 (voucher collection number - CPC 4553) in Na Hang District of Tuyen Quang Province remained unstudied before our research. In conditions of very small global population, project studies are outstandingly

important for conservation of genetic diversity for further successful propagation of this ornamental tree producing extremely valuable timber.

The project investigation provides actually first original data on intact vegetation, habitat and natural conditions of primary plant community of *Xanthocyparis* populations found in Tuyen Quang Province. These data present objective picture of native conditions and character of primary environment. This gives new understanding of appropriate many-aspect ecology for reforestation and recovery of primary intact habitats and aboriginal plant communities for future. Additionally were discovered and studied 5 remnant populations in Cao Bang Province, which exhibit different successive stages of their degradation and extinction. Current tentative identification of present population status was based on direct observations and description of population square, population structure and population numerical strength in all discovered localities. These data are very significant for trace further population dynamics in coming future.

Populations discovered along the border of Tuyen Quang and Ha Giang Provinces, undoubtedly, represent largest portion of global species population and form essential pool of species genetic diversity. Being protected these primary woods may be used for any fundamental studies as typical model of globally most endangered primary coniferous endemic forest of karstic rocky limestone of northern Vietnam with their outstandingly rich species composition. Elaborated recommendations are significant for education of local human society and for further sustainable development of the region. Obtained original data of our investigation will contribute to Conservation Status Assessment and Conservation Action Plan IUCN of *Xanthocyparis vietnamensis* in all area of its distribution.

Main Project achievements

It was estimated approximate square and size of main known subpopulation of *Xanthocyparis vietnamensis* (Na Hang District, Sinh Long Municipality, around Khuoi Phin village, subpopulation №1, fig. 1 & 2: maps 1 & 2) that covers about 0.5 km² and includes about 50 mature trees. It is not possible to give exact figures as tree regularly grows on tops of highly eroded rocky limestone often with inaccessible cliffs.

It was newly discovered 1 additional subpopulation of *Xanthocyparis vietnamensis* in Tuyen Quang Province (Na Hang Distr., Sinh Long Municipality, around Khuoi Phin village, population №2, fig. 1 & 2: maps 1 & 2). It covers about 0.2 km² and includes about 15 mature trees.

It was detected 1 large intact population of *Xanthocyparis vietnamensis* on the border of Tuyen Quang and Bac Me Distr. of Ha Giang Provinces (probably largest known intact populations at all). Fig. 1 & 2: maps 1 & 2.

It was newly discovered and directly studied 4 remnant populations in close vicinities in Cao Bang Province:

- Population 3 (fig. 1 & 3: maps 1 & 3). Nguyen Binh Distr., Ca Thanh Municipality, Ta Pin village. It was observed 6 mature trees on square about 0.2 km².
- Population 4 (fig. 1 & 4: maps 1 & 4). Nguyen Binh Distr., Yen Lac Municipality, Chi Doi village. It was observed 1 mature and 3 immature trees on square about 0.1 km².
- Population 5 (fig. 1 & 4: maps 1 & 4). Thong Nong Distr., Yen Son Municipality, Ngan Vai village. It was observed 1 alive mature tree and many died on square about 0.4 km².
- Population 6 (fig. 1 & 4: maps 1 & 4). Thong Nong Distr., Yen Son Municipality, Nhieu Lung village. It was observed 2 mature and 3 immature trees on square about 0.5 km².

It was described habitats and vegetation structure in all 6 discovered populations of *Xanthocyparis vietnamensis* with short data about natural conditions (short soil descriptions and climate extrapolations). It was also provided list of most typical plant species occurring in *Xanthocyparis* habitats based on collected voucher herbarium specimens. 12 species were discovered in the project field investigations as a new species for science.

It was estimated number of trees, population size, structure and identified species status for each discovered population as follow:

Population 1: about 50 mature trees / square about 0.5 km² / no young trees, no regeneration / tentative status: endangered.

Population 2: about 15 mature trees / square about 0.2 km² / no young trees, no regeneration / tentative status: endangered.

Population 3: it was observed 6 mature trees / square about 0.2 km² / no young trees, no regeneration / tentative status: critically endangered.

Population 4: it was observed 1 mature and 3 immature trees / square about 0.1 km² / no regeneration / tentative status: endangered.

Population 5: it was found 1 alive mature tree among many died and logged samples / on former square about 0.4 km² / no young trees, no regeneration / tentative status: critically endangered.

Population 6: it was observed 2 mature and 3 immature depressed trees / square about 0.5 km² / no regeneration / tentative status: critically endangered.

Largest intact population was observed on the border of Tuyen Quang and Ha Giang Province. It was preliminarily assessed as vulnerable.

Seeds of *Xanthocyparis vietnamensis* were collected for study of their fertility and testing of seed propagation.

It was at first specially studied seed phenology, seed production and seed fertility with following main results:

Species seed maturity is observed in studied populations depending on weather in August – October. Optimal time for ripe seed collecting in year 2013 in studied area were first 2 weeks of September. Portion of seeds with developed endosperm in different studied samples varied from 0 to about 10%, from 90 to 100% seeds were empty.

Full conservation and protection of remaining samples of *Xanthocyparis vietnamensis* in all discovered localities is extremely important for further propagation and salvation of the species genetic richness. Well understanding of this problem by FPD and other Vietnamese authorities of different levels meets a some certain conflict with local peoples who consider forest in their native area as their property. The timber of the tree is outstandingly valuable for home and other village or farm constructions and was widely used by locals during ages up to now hence it resource become miserable. Chinese dealers, which offer high price for the timber represent additional serious problem for salvation of mature trees. Cultivation and plantation of *Xanthocyparis* in such circumstances are most important way for species protection and conservation. Organization of the tree propagation by seeds and cuttings with moderate financial dotation to local families for tree plantation in its native area looks alone effective way for species conservation in long term future. Such plan is actually elaborated by project team.

Schematic illustrated preliminary report of completed research is presented here. Manuscript of illustrated assessment with main results of investigation is now in processing for preparation for publication

Short schematic resume of main items of activity is presented below in form of tables:

Table 1. Schedule, activity and main results

Dates 2013	Activity items	Locality	Short results	Voucher collections
Sept. 25	Arrival of Leonid Averyanov to Hanoi	Hanoi	Arrival and preparation for field works	-
Sept. 25-26	Preparation for field works	Hanoi	Preparation for field works	-
Sept. 27-28	Trip Hanoi – Tuyen Quang Prov., Na Hang District, Sinh Long Mun.	Tuyen Quang Prov., Na Hang District, Sinh Long Mun.	Registration and processing permissions for field work, works with FPD authorities. Getting permissions and elaborating of field work plan	-
Sept. 29	Field work	Na Hang District, Sinh Long Municipality, Khuoi Phin village	Discovery and description of <i>Xanthocyparis</i> population and habitat (locality №1), preliminary assessment. Collecting of voucher specimens for habitat description	CPC 5291-5324 Subtotal: 34 <i>Xanthocyparis</i> : CPC 5292 population №1
Sept. 30	Field work	Na Hang District, Sinh Long Mun., Khuoi Phin village	Discovery and description of <i>Xanthocyparis</i> population and habitat (locality №2), preliminary assessment. Collecting of voucher specimens for habitat description	CPC 5325-5345 Subtotal: 21 <i>Xanthocyparis</i> : CPC 5336 population №2
Oct. 1-2	Trip Tuyen Quang Prov. – Cao Bang Prov., Nguyen Binh District, Ca Thanh Mun.	Cao Bang Prov., Nguyen Binh District	Registration and processing permissions for field work, works with FPD authorities. Getting permissions and elaborating of field work plan	-
Oct. 3	Field work	Cao Bang Prov., Nguyen Binh District, Ca Thanh Mun., Ta Pin village	Field explorations of the area for <i>Xanthocyparis</i> populations, searches of information among local peoples, studies of typical species	CPC 5346-5382 Subtotal: 37
Oct. 4	Field work	Cao Bang Prov., Nguyen Binh District, Ca Thanh Mun., Cao Lu village	Field explorations of the area for <i>Xanthocyparis</i> populations, searches of information among local peoples, studies of typical species	CPC 5383-5416 Subtotal: 34
Oct. 5-6	Field work	Cao Bang Prov., Nguyen Binh District, Ca Thanh Mun., Ta Pin village	Discovery and description of <i>Xanthocyparis</i> population and habitat (locality №3 and 4), preliminary assessment. Collecting of voucher specimens for habitat description	CPC 5417-5435 Subtotal: 19 <i>Xanthocyparis</i> : CPC 5419 population №3, CPC 5427 population №4
Oct. 7	Field work	Cao Bang Prov., Thong Nong District, Yen Son Mun., Ngan Vai village	Discovery and description of <i>Xanthocyparis</i> population and habitat (locality №5), preliminary assessment. Collecting of voucher specimens for habitat description	CPC 5436-5455 Subtotal: 20 <i>Xanthocyparis</i> : CPC 5438 population №5
Oct. 8-10	Field work	Cao Bang Prov., Thong Nong District, Yen Son Mun., Nhieu Lung village	Discovery and description of <i>Xanthocyparis</i> population and habitat (locality №6), preliminary assessment. Collecting of voucher specimens for habitat description	CPC 5456-5478 Subtotal: 23 <i>Xanthocyparis</i> : CPC 5468 population №6
Oct. 11	Trip Cao Bang Prov., Nguyen Binh District - Hanoi	Cao Bang, Nguyen Binh, Hanoi	-	-
Oct. 12-14	Hanoi	Hanoi	Processing of field collections, field observations and field books, preliminary identifications of voucher herbarium specimens	-
Total: 154 (about 700 herbarium specimens)				

Table 2. Project field work time allocation:

Kind of activity	Numbers of days
Trips and processing permissions days:	5
Field work days:	10
Exploration preparation, material processing days:	5
Total days of the project exploration:	20

Table 3. Main field work results

Kind of activity	Numbers of days
Discovered and described <i>Xanthocypris</i> populations:	6
Assessed <i>Xanthocypris</i> populations:	6
Collected voucher herbarium specimens:	154 (CPC 5291-5468)
Collected plant families	46
Collected plant genera	95
Collected plant species	about 153

It was discovered and studied 6 *Xanthocypris vietnamensis* populations in Tuyen Quang and Cao Bang Provinces (Table 4).

Table 4. Discovered and studied 6 *Xanthocypris vietnamensis* populations in Tuyen Quang and Cao Bang Provinces

Administry Position	Geographical position	Elevation (in m)	Collecting №	Date
Tuyen Quang Province				
1. Na Hang District, Sinh Long Municipality, Khuoi Phin village	22°38'21.9"N, 105°20'43.5"E	1100-1200	CPC 5292	29 Sept. 2013
2. Na Hang District, Sinh Long Municipality, Khuoi Phin village	22°38'21"N, 105°20'28"E	1100-1200	CPC 5336	30 Sept. 2013
Cao Bang Province				
3. Nguyen Binh District, Ca Thanh Municipality, Ta Pin village	22°43'56.4"N, 105°51'16.4"E	1400	CPC 5419	5 Oct. 2013
4. Nguyen Binh District, Yen Lac Municipality, Chi Doi village	22°45'34"N, 105°51'48.7"E	1400	CPC 5427	5 Oct. 2013
5. Thong Nong District, Yen Son Municipality, Ngan Vai village	22°46'53"N, 105°52'58.7"E	1300	CPC 5438	7 Oct. 2013
6. Thong Nong District, Yen Son Municipality, Nhieu Lung village	22°46'07.9"N, 105°53'59.4"E	1150-1250	CPC 5468	8 Oct. 2013

Key plant groups collected in habitats of *Xanthocypris vietnamensis*:

1. Gymnosperms

Taxaceae: *Amentotaxus argotaenia*, *Taxus chinensis*; **Cephalotaxaceae:** *Cephalotaxus mannii*; **Cupressaceae:** *Calocedrus rupestris*, *Fokienia hodginsii*, *Xanthocypris vietnamensis*; **Pinaceae:** *Pinus fenzeliana* (*kwangtungensis*), *Pseudotsuga sinensis*, *Tsuga chinensis*; **Podocarpaceae:** *Nageia fleuryi*, *Podocarpus pilgeri*.

2. Local endemics

Anoectochilus calcareus, *Bulbophyllum longibrachiatum*, *Coelogyne malipoensis*, *Gastrochilus kaduriei*, *Holcoglossum lingulatum*, *Liparis superposita*, *Luculia yunnanensis*, *Paphiopedilum henryanum*, *Paphiopedilum malipoense*, *Paphiopedilum micranthum*, *Pholidota missionariorum*, *Podophyllum tonkinense*, *Rhomboda petelottii*, *Trachycarpus geminisectus*, *Tupistra longispica*.

3. Globally threatened species

Calocedrus rupestris, *Paphiopedilum henryanum*, *Paphiopedilum malipoense*, *Paphiopedilum micranthum*, *Podophyllum tonkinense*, *Taxus chinensis*, *Trachycarpus geminisectus*, *Xanthocypris vietnamensis*.

4. Threatened timber trees widely logging for valuable timber

Calocedrus rupestris, *Castanopsis* sp., *Fokienia hodginsii*, *Lithocarpus* sp., *Magnolia liliifera*, *Michelia fulva*, *Michelia* sp., *Pinus fenzeliana*, *Podocarpus pilgeri*, *Pseudotsuga sinensis*, *Quercus* sp., *Tsuga chinensis*, *Xanthocyparis vietnamensis*.

5. Non timber threatened species widely collected for sale (mainly as medicinal and ornamental plants)

Aconitum carmichaeli, *Anoectochilus calcareus*, *Cymbidium ensifolium*, *Dendrobium chrysanthum*, *Goodyera hispida*, *Holcoglossum lingulatum*, *Holcoglossum subulifolium*, *Lysimachia insignis*, *Mahonia nepalensis*, *Paphiopedilum henryanum*, *Paphiopedilum malipoense*, *Paphiopedilum micranthum*, *Paris chinensis*, *Podocarpus pilgeri*, *Podophyllum tonkinense*.

6. New species for science discovered in studied area

Aspidistra oviflora (CPC 5425), *Aspidistra* sp.nov.1 (CPC 5455), *Aspidistra* sp.nov.2 (CPC 5470), *Aspidistra* sp.nov.3 (CPC 5478), *Gastrochilus kaduriei* sp.nov.(CPC 5323; CPC 5354; CPC 5442; CPC 5467), *Lyrioep* sp.nov. (CPC 5363), *Ophiopogon subfrutescens* sp.nov. (CPC 5345), *Ophiopogon* sp.nov.1 (CPC 5313), *Ophiopogon* sp.nov.2 (CPC 5429), *Ophiopogon* sp.nov.3 (CPC 5460), *Ophiopogon* sp.nov.4 (CPC 5473), *Rohdea platiphylla* sp.nov. (CPC 5299). Totally 12 species.

Families collected:

Apiaceae, Aquifoliaceae, Araliaceae, Arecaceae, Asteraceae, Balanophoraceae, Begoniaceae, Berberidaceae, Betulaceae, Burmanniaceae, Caprifoliaceae, Celastraceae, Cephalotaxaceae, Clusiaceae, Convallariaceae, Cupressaceae, Ericaceae, Euphorbiaceae, Fabaceae, Fagaceae, Gentianaceae, Gesneriaceae, Iteaceae, Linaceae, Lycopodiaceae, Magnoliaceae, Melastomataceae, Myrsinaceae, Orchidaceae, Pinaceae, Pittosporaceae, Podocarpaceae, Podophyllaceae, Polygalaceae, Polypodiaceae, Primulaceae, Psilotaceae, Ramnaceae, Ranunculaceae, Rubiaceae, Sapotaceae, Taxaceae, Trilliaceae, Urticaceae, Valerianaceae, Verbenaceae (totally 46).

Genera collected:

Aconitum, *Aeschynanthus*, *Amentotaxus*, *Anemone*, *Anoectochilus*, *Aspidistra*, *Asplenium*, *Balanophora*, *Begonia*, *Blastus*, *Boea*, *Bulbophyllum*, *Burmannia*, *Calanthe*, *Calcareoboaea*, *Callicarpa*, *Calocedrus*, *Carpinus*, *Castanopsis*, *Cephalotaxus*, *Cheilanthes*, *Chirita*, *Coelogyne*, *Crepidiastrum*, *Crowfordia*, *Crypsinus*, *Cymbidium*, *Cyrtomium*, *Dendrobium*, *Diplasium*, *Elatostema*, *Elephantopus*, *Epigeneium*, *Eria*, *Evonimus*, *Fokienia*, *Garcinia*, *Gastrochilus*, *Goodyera*, *Gynura*, *Hedyotis*, *Holcoglossum*, *Huperzia*, *Hydrocotyle*, *Ilex*, *Itea*, *Lepisorus*, *Liparis*, *Lithocarpus*, *Luculia*, *Lycopodium*, *Lyrioep*, *Lysimachia*, *Magnolia*, *Mahonia*, *Michelia*, *Miguelia*, *Myrsine*, *Nephelaphyllum*, *Onichium*, *Ophiopogon*, *Ophiorrhiza*, *Paphiopedilum*, *Paramussaenda*, *Paris*, *Patrinia*, *Phaius*, *Pholidota*, *Pinus*, *Pittosporum*, *Podocarpus*, *Podochilus*, *Podophyllum*, *Polygala*, *Polystichum*, *Porpax*, *Pseudotsuga*, *Psilotum*, *Pteris*, *Quercus*, *Rhododendron*, *Rhomboda*, *Rhynchothecum*, *Rohdea*, *Schefflera*, *Taxus*, *Thalictrum*, *Tirpitzia*, *Trachycarpus*, *Tsuga*, *Tupistra*, *Vaccinium*, *Viburnum*, *Xanthocyparis* (totally 95).

ILLUSTRATIONS

(photos of L.Averyanov, N.S.Khang, N.T.Hiep, P.V.The; maps by N.S.Khang, L.Averyanov)

- Fig. 1.** Map 1. Distribution of *Xanthocyparis vietnamensis* in Vietnam and locations of discovered and assessed populations.
- Fig. 2.** Map 2. Locations of studied and assessed populations of *Xanthocyparis vietnamensis* in Tuyen Quang Province, Na Hang District, Sinh Long Municipality in vicinities of Khuoi Phin village, populations №1 and №2.
- Fig. 3.** Map 3. Locations of studied and assessed populations of *Xanthocyparis vietnamensis* in Cao Bang Province, Nguyen Binh District, Ca Thanh Municipality in vicinity of Ta Pin village, populations №3.
- Fig. 4.** Map 4. Locations of studied and assessed populations of *Xanthocyparis vietnamensis* in Cao Bang Province, Nguyen Binh District, Yen Lac Municipality (vicinity of Chi Doi village) and in Thong Nong District, Yen Son Municipality (vicinities of Ngan Vai and Nhieu Lung villages), populations №4-6.
- Fig. 5, 6.** Typical landscape in *Xanthocyparis vietnamensis* native area with remnants of primary forests on north faced slopes at limestone hill tops (Cao Bang Province, Thong Nong District, Yen Son Municipality vicinities of Nhieu Lung village).
- Fig. 7.** Primary seasonal evergreen coniferous, mixed and broad-leaved forests on tops of rocky limestone mountains is home of *Xanthocyparis vietnamensis* in studied area. Coniferous forest with domination of *Pseudotsuga sinensis* in Cao Bang Prov., Thong Nong District, Yen Son Municipality, vicinities of Ngan Vai village (population of *Xanthocyparis vietnamensis* №5).
- Fig. 8.** Primary seasonal evergreen coniferous, mixed and broad-leaved forests on tops of rocky limestone mountains is home of *Xanthocyparis vietnamensis* in studied area. Coniferous and mixed forest with domination and co-domination of *Pseudotsuga sinensis* in Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinities of Nhieu Lung village (population of *Xanthocyparis vietnamensis* №6).
- Fig. 9.** Primary seasonal evergreen coniferous, mixed and broad-leaved forests on tops of rocky limestone mountains is home of *Xanthocyparis vietnamensis* in studied area. Broad-leaved and mixed forest with co-domination of *Xanthocyparis vietnamensis* in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinities of Khuoi Phin village (population of *Xanthocyparis vietnamensis* №1).
- Fig. 10.** Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Pseudotsuga sinensis* Dode (collection № CPC 5436).
- Fig. 11.** Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Pinus fenzeliana* Hand.-Mazz. (collection № CPC 5435).
- Fig. 12.** Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Podocarpus pilgeri* Foxw. (collection № CPC 5341).
- Fig. 13.** Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Castanopsis* sp. (collection № CPC 5434).
- Fig. 14.** Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Quercus* sp. (collection № CPC 5380).
- Fig. 15, 16.** Intact primary coniferous forest with domination of *Xanthocyparis vietnamensis*. Discovered population on the border of Tuyen Quang and Ha Giang Provinces, maps 1 & 2 (fig. 1, 2).
- Fig. 17-19.** *Xanthocyparis vietnamensis* in studied population № 1, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, collection № CPC 5292, maps 1 & 2 (fig. 1, 2).
- Fig. 20-25.** *Xanthocyparis vietnamensis* in studied population № 2, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, collection № CPC 5336, maps 1 & 2 (fig. 1, 2).

- Fig. 26-30.** *Xanthocyparis vietnamensis* in studied population № 4, Cao Bang Province, Nguyen Binh District, Yen Lac Municipality, vicinity of Chi Doi village, collection № CPC 5427, maps 1 & 4 (fig. 1, 4).
- Fig. 31.** *Xanthocyparis vietnamensis* in studied population № 5, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinity of Ngan Vai village, collection № CPC 5438, maps 1 & 4 (fig. 1, 4).
- Fig. 32-34.** *Xanthocyparis vietnamensis* in studied population № 6, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinity of Nhieu Lung village, collection № CPC 5468, maps 1 & 4 (fig. 1, 4).
- Fig. 35-39.** Evidence of *Xanthocyparis vietnamensis* logging in remote past. Tree remains in studied population № 4, Cao Bang Province, Nguyen Binh District, Yen Lac Municipality, vicinities of Chi Doi village, maps 1 & 4 (fig. 1, 4).
- Fig. 40-44.** Evidence of *Xanthocyparis vietnamensis* logging in present time. Tree and timber remains in studied population № 1 & 2, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, maps 1 & 2 (fig. 1, 2).
- Fig. 45, 46.** Transportation of logged timber of *Xanthocyparis vietnamensis* in present time. Observed transported timber in studied population № 1 & 2, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, maps 1 & 2 (fig. 1, 2).
- Fig. 47.** Naturally died trees of *Xanthocyparis vietnamensis* in present time observed in discovered locality № 5, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinity of Ngan Vai village, maps 1 & 4 (fig. 1, 4).
- Fig. 48, 49.** Traditional use of *Xanthocyparis vietnamensis* timber in village and farm constructions. Cao Bang Province, Thong Nong District, Yen Son Municipality, Ngan Vai village.
- Fig. 50-52.** Present use of *Xanthocyparis vietnamensis* timber for furniture handicrafts. Cao Bang Province, Thong Nong District.
- Fig. 53.** Coniferous branches of *Xanthocyparis vietnamensis* with numerous ripe female cones observed in optimal conditions in intact population №1 in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, Khuoi Phin village (collection № CPC 5292) in 29 September 2013.
- Fig. 54-58.** Ripe (still close and starting opening) female cones on branches of *Xanthocyparis vietnamensis* observed in optimal conditions in intact population №1 in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, in vicinity of Khuoi Phin village (collection № CPC 5292) in 29 September 2013.
- Fig. 59, 60.** Open female cones with just completely dispersed seeds on branches of *Xanthocyparis vietnamensis* observed in population №6, in Cao Bang Province, Thong Nong District, Yen Son Municipality, in vicinity of Nhieu Lung village, (collection № CPC 5468) in 8 October 2013.
- Fig. 61.** Section of ripe female cone of *Xanthocyparis vietnamensis* with ripe normally developed seeds observed in population №1 in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, in vicinity of Khuoi Phin village (collection № CPC 5292) in 29 September 2013.
- Fig. 62.** Normally developed seeds of *Xanthocyparis vietnamensis* from ripe cone observed in population №1 in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, in vicinity of Khuoi Phin village (collection № CPC 5292) in 29 September 2013.
- Fig. 63.** Cultivated saplings of *Podocarpus pilgeri* Foxw. growing by local peoples in their home gardens, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinities of Nhieu Lung village.
- Fig. 64.** *Trachycarpus geminisectus* Spanner et al., example of critically endangered species in habitats of *Xanthocyparis vietnamensis* (collection № CPC 5291, Tuyen Quang Province., Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village).
- Fig. 65, 66.** *Paphiopedilum henryanum* Braem, example of critically endangered species in habitats of *Xanthocyparis vietnamensis* (collection № CPC 5294, Tuyen Quang Province., Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village).

- Fig. 67.** *Paphiopedilum micranthum* Tang et F.T.Wang, example of critically endangered species in habitats of *Xanthocypris vietnamensis* (collection № CPC 5359, Cao Bang Province Nguyen Binh Distr., Ca Thanh Municipality, vicinity of Ta Pin village).
- Fig. 68, 69.** *Coelogyne malipoensis* Z.H.Tsi, example of critically endangered species in habitats of *Xanthocypris vietnamensis* (collection № CPC 5353, Cao Bang Province, Nguyen Binh Distr., Ca Thanh Municipality, vicinity of Ta Pin village).
- Fig. 70.** *Holcoglossum lingulatum* (Aver.) Aver., example of critically endangered species in habitats of *Xanthocypris vietnamensis* (collection № CPC 5360, Cao Bang Province, Nguyen Binh Distr., Ca Thanh Municipality, vicinity of Ta Pin village).
- Fig. 70, 72.** *Gastrochilus kadooriei* sp. nov., example of species new for science discovered in habitats of *Xanthocypris vietnamensis* during field works (collection № CPC 5467, Cao Bang Province, Thong Nong Distr., Yen Son Municipality, Nhieu Lung village).
- Fig. 73.** *Aspidistra oviflora* sp. nov., example of species new for science discovered in habitats of *Xanthocypris vietnamensis* during field works (collection № CPC 5470, Cao Bang Province, Thong Nong Distr., Yen Son Municipality, Nhieu Lung village).

Fig. 1. Map 1. Distribution of *Xanthocypris vietnamensis* in Vietnam and locations of discovered and assessed populations.

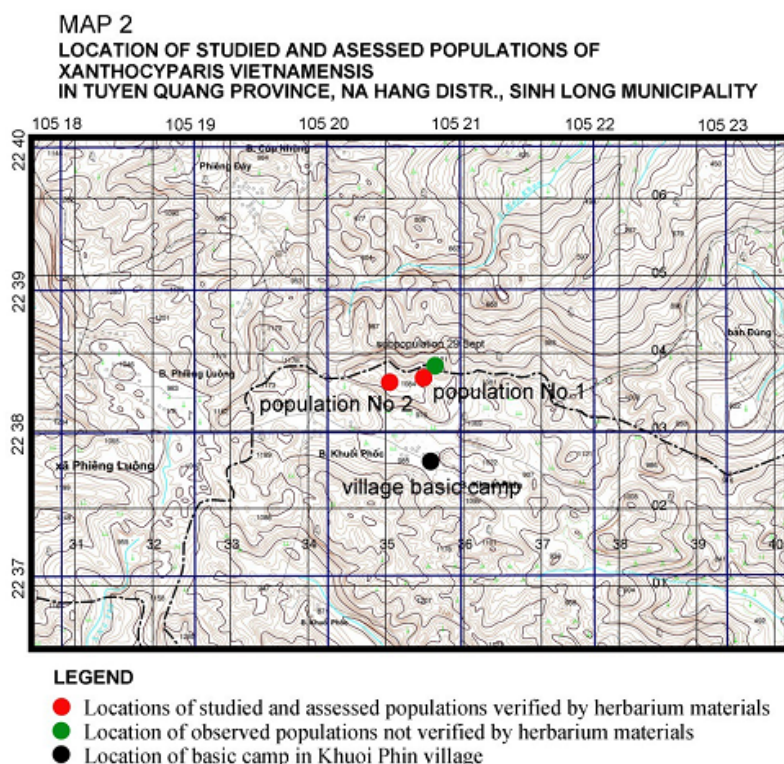


Fig. 2. Map 2. Locations of studied and assessed populations of *Xanthocypris vietnamensis* in Tuyen Quang Province, Na Hang District, Sinh Long Municipality in vicinities of Khuoi Phin village, populations №1 and №2.

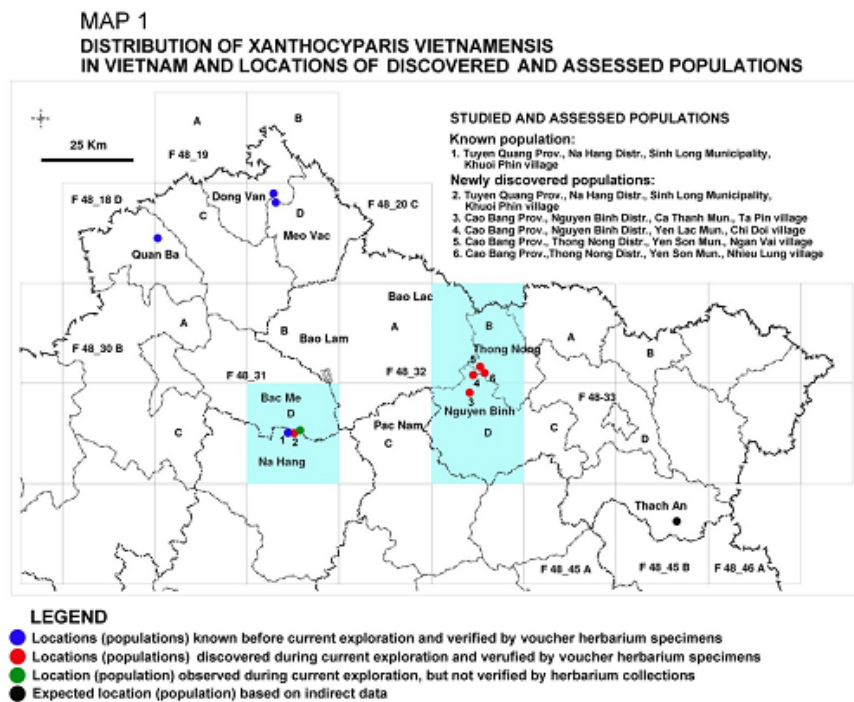


Fig. 3. Map 3. Locations of studied and assessed populations of *Xanthocypris vietnamensis* in Cao Bang Province, Nguyen Binh District, Ca Thanh Municipality in vicinity of Ta Pin village, populations №3.

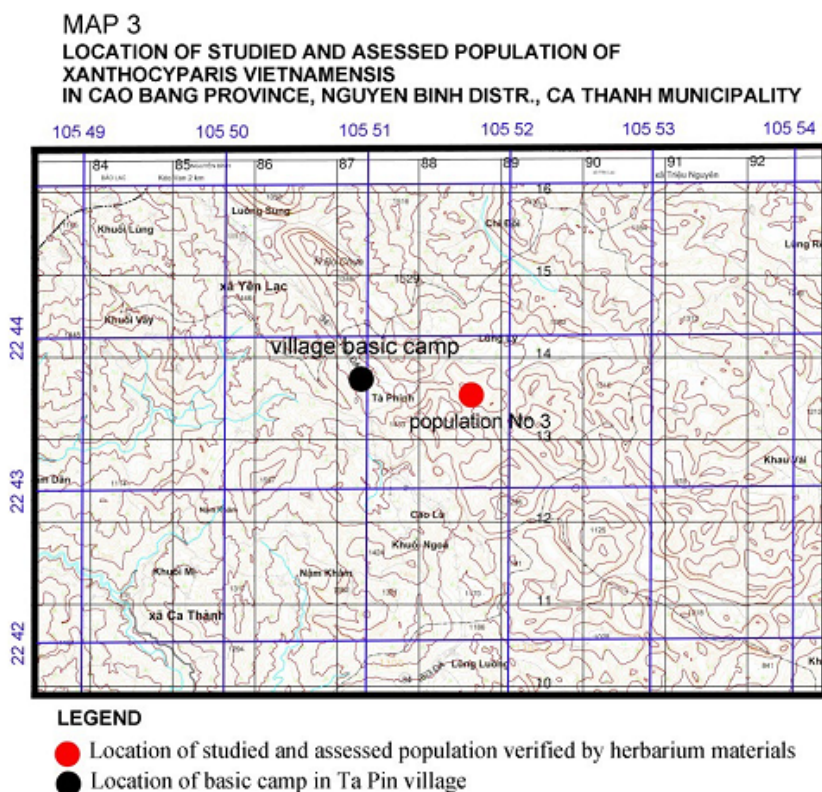


Fig. 4. Map 4. Locations of studied and assessed populations of *Xanthocyparis vietnamensis* in Cao Bang Province, Nguyen Binh District, Yen Lac Municipality (vicinity of Chi Doi village) and in Thong Nong District, Yen Son Municipality (vicinities of Ngan Vai and Nhieung Lung villages), populations №4-6.

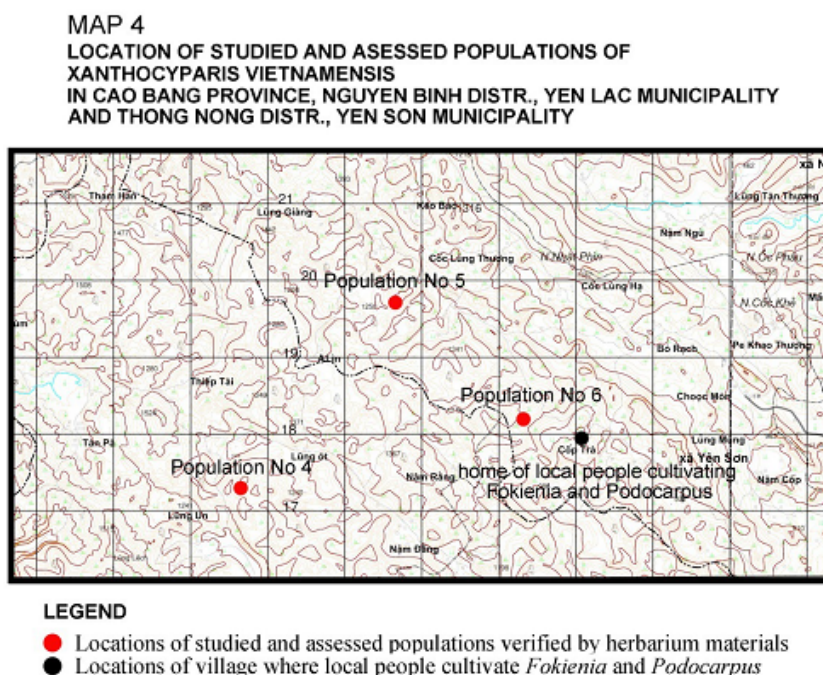


Fig. 5, 6. Typical landscape in *Xanthocyparis vietnamensis* native area with remnants of primary forests on north faced slopes at limestone hill tops (Cao Bang Province, Thong Nong District, Yen Son Municipality vicinities of Nhieung Lung village).





Fig. 7. Primary seasonal evergreen coniferous, mixed and broad-leaved forests on tops of rocky limestone mountains is home of *Xanthocyparis vietnamensis* in studied area. Coniferous forest with domination of *Pseudotsuga sinensis* in Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinities of Ngan Vai village (population of *Xanthocyparis vietnamensis* №5).

of Nhieu Lung village (population of *Xanthocyparis vietnamensis* №6).

Fig. 8. Primary seasonal evergreen coniferous, mixed and broad-leaved forests on tops of rocky limestone mountains is home of *Xanthocyparis vietnamensis* in studied area. Coniferous and mixed forest with domination and co-domination of *Pseudotsuga sinensis* in Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinities



Fig. 9. Primary seasonal evergreen coniferous, mixed and broad-leaved forests on tops of rocky limestone mountains is home of *Xanthocyparis vietnamensis* in studied area.



Broad-leaved and mixed forest with co-domination of *Xanthocyparis vietnamensis* in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinities of Khuoi Phin village (population of *Xanthocyparis vietnamensis* №1).



Fig. 10. Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Pseudotsuga sinensis* Dode (collection № CPC 5436).

Fig. 11. Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Pinus fenzeliana* Hand.-Mazz. (collection № CPC 5435).



Fig. 12. Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocyparis vietnamensis*. *Podocarpus pilgeri* Foxw. (collection № CPC 5341).





Fig. 13. Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocypris vietnamensis*. *Castanopsis* sp. (collection № CPC 5434).

Fig. 14. Main tree co-dominants of the first (canopy) forest stratum in habitats of *Xanthocypris vietnamensis*. *Quercus* sp. (collection № CPC 5380).



Fig. 15, 16. Intact primary coniferous forest with domination of *Xanthocypris vietnamensis*. Discovered population on the border of Tuyen Quang and Ha Giang Provinces, maps 1 & 2 (fig. 1, 2).





Fig. 17-19. *Xanthocyparis vietnamensis* in studied population № 1, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, collection № CPC 5292, maps 1 & 2 (fig. 1, 2).





Fig. 20-25. *Xanthocypris vietnamensis* in studied population № 2, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, collection № CPC 5336, maps 1 & 2 (fig. 1, 2).





Fig. 26-30. *Xanthocyparis vietnamensis* in studied population № 4, Cao Bang Province, Nguyen Binh District, Yen Lac Municipality, vicinity of Chi Doi village, collection № CPC 5427, maps 1 & 4 (fig. 1, 4).





Fig. 31. *Xanthocyparis vietnamensis* in studied population № 5, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinity of Ngan Vai village, collection № CPC 5438, maps 1 & 4 (fig. 1, 4).

Fig. 32-34. *Xanthocyparis vietnamensis* in studied population № 6, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinity of Nhieu Lung village, collection № CPC 5468, maps 1 & 4 (fig. 1, 4).





Fig. 35-39. Evidence of *Xanthocypris vietnamensis* logging in remote past. Tree remains in studied population № 4, Cao Bang Province, Nguyen Binh District, Yen Lac Municipality, vicinities of Chi Doi village, maps 1 & 4 (fig. 1, 4).





Fig. 40-44. Evidence of *Xanthocyparis vietnamensis* logging in present time. Tree and timber remains in studied population № 1 & 2, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, maps 1 & 2 (fig. 1, 2).





Fig. 45, 46. Transportation of logged timber of *Xanthocyparis vietnamensis* in present time. Observed transported timber in studied population № 1 & 2, Tuyen Quang Province, Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village, maps 1 & 2 (fig. 1, 2).



Fig. 47. Naturally died trees of *Xanthocyparis vietnamensis* in present time observed in discovered locality № 5, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinity of Ngan Vai village, maps 1 & 4 (fig. 1, 4).



Fig. 48, 49. Traditional use of *Xanthocyparis vietnamensis* timber in village and farm constructions. Cao Bang Province, Thong Nong District, Yen Son Municipality, Ngan Vai village.





Fig. 50-52. Present use of *Xanthocyparis vietnamensis* timber for furniture handicrafts. Cao Bang Province, Thong Nong District.





Fig. 53. Coniferous branches of *Xanthocyparis vietnamensis* with numerous ripe female cones observed in optimal conditions in intact population №1 in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, Khuoi Phin village (collection № CPC 5292) in 29 September 2013.

Fig. 54-58. Ripe (still close and starting opening) female cones on branches of *Xanthocyparis vietnamensis* observed in optimal conditions in intact population №1 in Tuyen Quang Province, Na Hang District,

Sinh Long Municipality, in vicinity of Khuoi Phin village (collection № CPC 5292) in 29 September 2013.







Fig. 59, 60. Open female cones with just completely dispersed seeds on branches of *Xanthocyparis vietnamensis* observed in population №6, in Cao Bang Province, Thong Nong District, Yen Son Municipality, in vicinity of Nhieu Lung village, (collection № CPC 5468) in 8 October 2013.



Fig. 61. Section of ripe female cone of *Xanthocyparis vietnamensis* with ripe normally developed seeds observed in population №1 in



Tuyen Quang Province, Na Hang District, Sinh Long Municipality, in vicinity of Khuoi Phin village (collection № CPC 5292) in 29 September 2013.



Fig. 62. Normally developed seeds of *Xanthocyparis vietnamensis* from ripe cone observed in population №1 in Tuyen Quang Province, Na Hang District, Sinh Long Municipality, in vicinity of Khuoi Phin village (collection № CPC 5292) in 29 September 2013.

Fig. 63. Cultivated saplings of *Podocarpus pilgeri* Foxw. growing by local peoples in their home gardens, Cao Bang Province, Thong Nong District, Yen Son Municipality, vicinities of Nhieu Lung village.



Fig. 64. *Trachycarpus geminisectus* Spanner et al., example of critically endangered species in habitats of *Xanthocyparis vietnamensis* (collection № CPC 5291, Tuyen Quang Province., Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village).





Fig. 65, 66. *Paphiopedilum henryanum* Braem, example of critically endangered species in habitats of *Xanthocyparis vietnamensis* (collection № CPC 5294, Tuyen Quang Province., Na Hang District, Sinh Long Municipality, vicinity of Khuoi Phin village).



Fig. 67. *Paphiopedilum micranthum* Tang et F.T.Wang, example of critically endangered species in habitats of *Xanthocyparis vietnamensis* (collection № CPC 5359, Cao Bang Province



Nguyen Binh Distr., Ca Thanh Municipality, vicinity of Ta Pin village).



Fig. 68, 69. *Coelogyne malipoensis* Z.H.Tsi, example of critically endangered species in habitats of *Xanthocypris vietnamensis* (collection № CPC 5353, Cao Bang Province, Nguyen Binh Distr., Ca Thanh Municipality, vicinity of Ta Pin village).



Fig. 70. *Holcoglossum lingulatum* (Aver.) Aver., example of critically endangered species in

habitats of *Xanthocypris vietnamensis* (collection № CPC 5360, Cao Bang Province, Nguyen Binh Distr., Ca Thanh Municipality, vicinity of Ta Pin village).





Fig. 70, 72. *Gastrochilus kadooriei* sp. nov., example of species new for science discovered in habitats of *Xanthocypris vietnamensis* during field works (collection № CPC 5467, Cao Bang Province, Thong Nong Distr., Yen Son



Fig. 73. *Aspidistra oviflora* sp. nov., example of species new for science discovered in habitats of *Xanthocypris vietnamensis* during field works (collection № CPC 5470, Cao Bang Province, Thong Nong Distr., Yen Son Municipality, Nhieu Lung village).



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