BULL. AUSTRAL. MATH. SOC. 30D50, 30D55,
VOL. 32 (1985), 195-205. 30F15, 31A05

BLASCHKE-TYPE MAPS AND HARMONIC MAJORATION ON RIEMANN SURFACES

SHINJI YAMASHITA

An analytic map h of type $B\ell$ from a Riemann surface R into another S, both having Green's functions, behaves well near the "boundary" of R. Let X stand for a family of holomorphic functions, and let f be holomorphic on S. We shall show, for several X's, the following:

(i) $f \in X(S) \Leftrightarrow f \circ h \in X(R)$;

(ii) $\|f \circ h\| = \|f\|$.

Use is made of harmonic majoration of subharmonic functions on R and on S.

1. Introduction

A Riemann surface R is called hyperbolic if R admits a Green's function $g_R(z,w)$ with pole $w \in R$. In the present paper, R and S denote hyperbolic Riemann surfaces. Let $h: R \to S$ be a nonconstant analytic map of type $B\ell$ in the sense of Heins [3, p. 440], namely, for each fixed $w \in S$ the superharmonic function $g_S(h(z),w)$ in R does not majorize any strictly positive and bounded harmonic function on R. Here, we say that a function f_1 majorizes another f_2 on R if $f_1 \geq f_2$ on R. Let $X(R)$ be a family of holomorphic functions on R. A motivation of the present paper arises from the following.

PROPOSITION X. *Let $h: R \to S$ be as above and suppose that f is holomorphic on S. Then, $f \in X(S)$ if and only if $f \circ h \in X(R)$, and in this case, the "norm" is invariant; symbolically, $\|f \circ h\| = \|f\|$.*

Received 8 January 1985

https://doi.org/10.1017/S0004972700009898 Published online by Cambridge University Press

To prove that Proposition X is valid for some X's , we need our main theorem. If a subharmonic function u on R is majorized by an harmonic function on R , then the least harmonic majorant $u_R^{\wedge}$ of u , the smallest among all harmonic functions majorizing u , exists.

THEOREM 1. *Let $h: R \to S$ be a nonconstant map of type $B\ell$, and let u be a subharmonic function on S majorizing a harmonic function on S . Then,*

(I) $u_S^{\wedge}$ exists if and only if $(u\circ h)_R^{\wedge}$ exists; if this is the case, then $u_S^{\wedge}\circ h = (u\circ h)_R^{\wedge}$ on R ;

(II) furthermore,

$$\sup_{z\in R}[(u\circ h)_R^{\wedge} - u\circ h](z) = \sup_{z\in S}(u_S^{\wedge} - u)(z). \tag{1.1}$$

Note that if $h: R \to S$ is an arbitrary analytic map, and if $u_S^{\wedge}$ exists, then $(u\circ h)_R^{\wedge}$ exists with $(u\circ h)_R^{\wedge} \leqslant u_S^{\wedge}\circ h$.

THEOREM 2. *Proposition X is true for*

$$X = N,\ N^+,\ H^p,\ BMOA,\ H^p_\sigma \text{ and } BMOA_\sigma \qquad (0 < p < \infty).$$

Detailed explanations of "norms" for X's in Theorem 2 will be postponed. The class $N(R)$ consists of f such that $\log^+|f| = \max(\log|f|,0)$ is majorized by a harmonic function on R. Heins [4, Theorems 11.1 and 11.2, p. 440] shows that if f is meromorphic on S , then f is Lindelöfian on S if and only if $f\circ h$ is Lindelöfian. As a consequence, $f \in N(S)$ if and only if $f\circ h \in N(R)$. We shall give another proof of this. Theorem 2 for $X = N$ asserts much more about the "norm".

The other X's are:

- N^+ : the Smirnov class [10];
- H^p : the Hardy class [7], [8];
- $BMOA$: the family of holomorphic functions of bounded mean oscillation [6];
- H^p_σ : the hyperbolic Hardy class [12], [13];
- $BMOA_\sigma$: the family of holomorphic functions of hyperbolically bounded mean oscillation [11].

2. Proof of Theorem 1

The core of the proof is to establish (I) for the case $R = S = \Delta \equiv \{|z| < 1\}$.

LEMMA 2.1. *Let* u *be subharmonic in* Δ *and majorize a harmonic function there. Let* $h: \Delta \to \Delta$ *be of type* $B\ell$, *or, equivalently, a nonconstant inner function* [1, p. 24], [3, p. 454]. *Then* $u^\wedge_\Delta$ *exists if and only if* $(u\circ h)^\wedge_\Delta$ *exists; if this is the case, then*

$$u^\wedge_\Delta \circ h = (u\circ h)^\wedge_\Delta \ . \tag{2.1}$$

Proof. For simplicity we write $v^\wedge = v^\wedge_\Delta$. We may assume that $u \geqslant 0$ and u is nonconstant. Actually, let w be harmonic in Δ with $w \leqslant u$. Then

$$(u-w)^\wedge + w = u^\wedge \quad \text{and} \quad ((u-w)\circ h)^\wedge + w\circ h = (u\circ h)^\wedge ,$$

whence (2.1) holds if and only if

$$(u-w)^\wedge \circ h = ((u-w)\circ h)^\wedge .$$

First of all, if $u^\wedge$ exists, then $(u\circ h)^\wedge$ exists because $u\circ h \leqslant u^\wedge\circ h$. Thus, we must show that if $(u\circ h)^\wedge$ exists, then $u^\wedge$ exists and (2.1) holds. Furthermore, it suffices to show that if $(u\circ h)^\wedge$ exists, then

$$u^\wedge\circ h(0) = (u\circ h)^\wedge(0) . \tag{2.2}$$

For arbitrary $w \in \Delta$ we set $T_w(z) = (z+w)/(1+\bar{w}z)$. Then,

$$(u\circ h)^\wedge = (u\circ h\circ T_w\circ T_{-w})^\wedge \leqslant (u\circ h\circ T_w)^\wedge\circ T_{-w}$$
$$\leqslant (u\circ h)^\wedge\circ T_w\circ T_{-w} = (u\circ h)^\wedge$$

so that

$$(u\circ h)^\wedge\circ T_w = (u\circ h\circ T_w)^\wedge .$$

Since $h\circ T_w$ is inner and $h\circ T_w(0) = h(w)$, it follows that

$$(u\circ h)^\wedge(w) = (u\circ(h\circ T_w))^\wedge(0) = u^\wedge\circ(h\circ T_w)(0) = u^\wedge\circ h(w) .$$

For the proof of (2.2) we may assume that $h(0) = 0$. In fact, $H = T_{-h(0)}\circ h$ is inner and $H(0) = 0$. Since

$$u\circ h = u\circ T_{h(0)}\circ H ,$$

and since $u\circ T_{h(0)}$ is subharmonic in Δ, and since $(u\circ T_{h(0)}\circ H)^{\wedge}$ exists, it follows that

$$u^{\wedge}\circ h(0) = u^{\wedge}\circ T_{h(0)}\circ H(0) = (u\circ T_{h(0)})^{\wedge}\circ H(0) =$$

$$= (u\circ T_{h(0)}\circ H)^{\wedge}(0) = (u\circ h)^{\wedge}(0) .$$

Set $\Delta_r = \{|z| < r\}$, $0 < r < 1$, and set

$$u_r = u^{\wedge}_{\Delta_r} \text{ in } \Delta_r ,$$

$$= u \text{ on } |z| = r .$$

If the inequality

$$(2.3) \qquad (u_r\circ h)(0) \leqslant (u\circ h)^{\wedge}(0)$$

is true for all r, $0 < r < 1$, and for $h(0) = 0$, then letting $r \uparrow 1$ we obtain, since $u_r(0) = (u_r\circ h)(0)$, that

$$u^{\wedge}(0) \leqslant (u\circ h)^{\wedge}(0) ,$$

which, together with the obvious relation,

$$(u\circ h)^{\wedge}(0) \leqslant u^{\wedge}\circ h(0) = u^{\wedge}(0) ,$$

yields (2.2).

For the proof of (2.3) we fix r and we set

$$M = \max_{|z|=r} u(z) .$$

Then $M > 0$ and

$$(2.4) \qquad u_r(z) \leqslant M \quad \text{for all} \quad z \in \overline{\Delta_r} .$$

Now, for a.e. $\zeta \in \partial\Delta$, the limit exists,

$$h(\zeta) = \lim_{t\to 1-0} h(t\zeta) , \quad \text{and} \quad |h(\zeta)| = 1 .$$

By Egorov's theorem, for each $\varepsilon > 0$, there exists an open set $E \equiv E(\varepsilon)$ on $\partial\Delta$, and t, $0 < t < 1$, such that the linear Lebesgue measure $m(E) < \varepsilon/M$ and

$$(2.5) \qquad |h(t\zeta)| > r \quad \text{for all} \quad \zeta \in \partial\Delta \setminus E .$$

Let G_t be the component of the open set $h^{-1}(\Delta_r) \cap \Delta_t$, which

https://doi.org/10.1017/S0004972700009898 Published online by Cambridge University Press

contains 0. Then, for $z \in \Delta_t \cap \partial G_t$,

(2.6) $$u_r \circ h(z) - (u \circ h)\hat{}(z) = u \circ h(z) - (u \circ h)\hat{}(z) \leqslant 0$$

because $|h(z)| = r$. On the other hand, since $|h(z)| \leqslant r$ for $z \in A \equiv \partial\Delta_t \cap \partial G_t$, (2.4) yields

(2.7) $$u_r \circ h(z) \leqslant M \quad \text{for} \quad z \in A .$$

Furthermore, by (2.5) we have $z/t \in E$ for $z \in A$, whence

(2.8) $$m(A) \leqslant tm(E) < \varepsilon/M .$$

Let ω be the harmonic measure of A in Δ_t, that is, the harmonic function in Δ_t, which is continuously equal to 1 on A and 0 on $\partial\Delta_t \setminus A$. Then,

(2.9) $$\omega(0) = m(A) < \varepsilon/M$$

by (2.8). Note that $\omega(z) > 0$ for $z \in \Delta_t \cap \partial G_t$. Now, the maximum principle applied to the harmonic function

$$u_r \circ h - (u \circ h)\hat{} - M\omega$$

in $\dot{G}_t$, together with (2.6) and (2.7), shows that this function is nonpositive on the whole G_t because $u \geqslant 0$. In particular, the evaluation at 0 yields

$$u_r \circ h(0) \leqslant (u \circ h)\hat{}(0) + \varepsilon$$

by (2.9). Since $\varepsilon > 0$ is arbitrary we obtain (2.3).

LEMMA 2.2. *Let* π *be a universal covering map from* Δ *onto* R, *and let* u *be subharmonic on* R. *Then* $\hat{u}_R$ *exists if and only if* $(u \circ \pi)\hat{}_\Delta$ *exists. In this case* $\hat{u}_R \circ \pi = (u \circ \pi)\hat{}_\Delta$ *in* Δ *and*

(2.10) $$\sup_{w \in \Delta} [(u \circ \pi)\hat{}_\Delta - u \circ \pi](w) = \sup_{z \in R} (\hat{u}_R - u)(z) .$$

We do not assume that u majorizes a harmonic function.

Proof. Since $z = \pi(w)$ ranges over all R as w ranges over all Δ, (2.10) is apparent if $\hat{u}_R \circ \pi = (u \circ \pi)\hat{}$ is established. We use again $(u \circ \pi)\hat{} = (u \circ \pi)\hat{}_\Delta$, etc. Obviously, $(u \circ \pi)\hat{}$ exists if $\hat{u}_R$ exists; in this case $(u \circ \pi)\hat{} \leqslant \hat{u}_R \circ \pi$. Suppose that $(u \circ \pi)\hat{}$ exists. Since $(u \circ \pi)\hat{}$ is

https://doi.org/10.1017/S0004972700009898 Published online by Cambridge University Press

automorphic with respect to the cover transformation group consisting of Möbius transformations of Δ onto Δ, $v = (u\circ\pi)\hat{}\circ\pi^{-1}$ is well defined on R. Since $(u\circ\pi)\hat{} \geqslant u\circ\pi$ we obtain $v \geqslant u$, whence $u_R\hat{}$ exists and $v \geqslant u_R\hat{}$. Thus, $(u\circ\pi)\hat{} \geqslant u_R\hat{}\circ\pi$.

Proof of Theorem 1. Let $\pi_R: \Delta \to R$ and $\pi_S: \Delta \to S$ be universal covering maps, and apply Lemma 2.2 to $u\circ h$ on R. Then $(u\circ h\circ\pi_R)\hat{}$ exists if and only if $(u\circ h)_R\hat{}$ exists and

$$(2.11) \qquad (u\circ h)_R\hat{}\circ\pi_R = (u\circ h\circ\pi_R)\hat{} .$$

A single-valued branch of $\pi_S^{-1}\circ h\circ\pi_R$ in Δ, which we denote by $H = \pi_S^{-1}\circ h\circ\pi_R$, is locally of type $B\ell$, whence of type $B\ell$ by [3, Corollary, p. 472]. Then

$$(2.12) \qquad (u\circ h\circ\pi_R)\hat{} = (u\circ\pi_S\circ H)\hat{} ,$$

so that, Lemma 2.1, applied to the subharmonic function $u\circ\pi_S$ in Δ, and to the inner function H, asserts the existence of $(u\circ\pi_S)\hat{}$ and

$$(2.13) \qquad (u\circ\pi_S)\hat{}\circ H = (u\circ\pi_S\circ H)\hat{} = (u\circ h)_R\hat{}\circ\pi_R$$

by (2.11) and (2.12). Summing up these arguments, we know that $(u\circ h)_R\hat{}$ exists if and only if $(u\circ\pi_S)\hat{}$ exists; (2.13) holds in this case. On the other hand, by Lemma 2.2, again, $(u\circ\pi_S)\hat{}$ exists if and only if $u_S\hat{}$ exists, and in this case, $u_S\hat{}\circ\pi_S = (u\circ\pi_S)\hat{}$, whence, by (2.13),

$$(u\circ h)_R\hat{}\circ\pi_R = u_S\hat{}\circ\pi_S\circ H = u_S\hat{}\circ h\circ\pi_R \quad \text{on} \quad \Delta .$$

Consequently, the equality $(u\circ h)_R\hat{} = u_S\hat{}\circ h$ on R is established.

To prove (1.1) in (II) we first observe that

$$K \equiv \sup_{z\in R}[(u\circ h)_R\hat{} - u\circ h](z) = \sup_{w\in\Delta}[(u\circ h\circ\pi_R)\hat{} - u\circ h\circ\pi_R](w)$$

by (2.10) for $u\circ h$ on R. Since $u\circ h\circ\pi_R = u\circ\pi_S\circ H$, and since $(u\circ h\circ\pi_R)\hat{} = (u\circ\pi_S)\hat{}\circ H$ by (2.12) and (2.13), it follows that

(2.14) $$K = \sup_{w\in\Delta} [(u\circ\pi_S)\hat{} - u\circ\pi_S]\circ H(w) = \sup_{z\in H(\Delta)} v(z)$$

where $v = (u\circ\pi_S)\hat{} - u\circ\pi_S$ in Δ. Now, by the theorem of O. Frostman [2, p. 111], $\Delta \setminus H(\Delta)$ is of capacity zero, whence $H(\Delta)$ is dense in Δ. For each $z \in \Delta$, we then choose a sequence $\{z_n\}$ with $z_n \in H(\Delta)$ and $z_n \to z$. Since v is lower-semicontinuous, it follows that

$$K \geqslant \liminf_{n\to\infty} v(z_n) \geqslant v(z) .$$

We thus have

$$K \leqslant \sup_{z\in\Delta} v(z) \leqslant K ,$$

whence

$$K = \sup_{\zeta\in\Delta} [(u\circ\pi_S)\hat{} - u\circ\pi_S](\zeta) ,$$

which, together with (2.10) for $u\circ\pi_S$ on Δ, yields

$$K = \sup_{z\in S} (u_S\hat{} - u)(z) .$$

3. Proof of Theorem 2

(i) $X = N$. This is a consequence of Theorem 1 for $u = \log^+|f|$. The "norm" of $f \in N(R)$ is

$$\|f\|_{w,N(R)} = (\log^+|f|)\hat{}_R(w) .$$

where $w \in R$ is a fixed point. Then, for $f \in N(S)$,

$$\|f\circ h\|_{w,N(R)} = \|f\|_{h(w),N(S)} .$$

(ii) $X = N^+$. The Smirnov class $N^+(R)$ (= $S(R)$ in [10]) consists of all $f \in N(S)$ such that $\log^+|f|$ is majorized by a quasibounded harmonic function in the sense of Parreau [7] on R, or, equivalently, $(\log^+|f|)\hat{}$ is quasibounded, that is, the limiting function of a nondecreasing sequence of nonnegative and bounded harmonic functions on R. Note that $N^+(\Delta) = N^+$ in [1, p. 26]. Some observations must be added. We claim that if $v \geqslant 0$ is harmonic on S and if $v\circ h$ is quasibounded on R, then v is quasibounded on S. For the proof of this, we let

https://doi.org/10.1017/S0004972700009898 Published online by Cambridge University Press

$v = v_b + v_*$ be the Parreau decomposition of v, where $v_b \geqslant 0$ is quasibounded, and $v_* \geqslant 0$ is singular; see [7], [3], [10]. According to [3, Theorem 20.1, p. 468], $v_* \circ h$ is singular on R. Since $v \circ h \geqslant v_* \circ h$, and since the singular part $(v \circ h)_*$ of the decomposition of $v \circ h$ on R is zero, $0 = (v \circ h)_* \geqslant v_* \circ h$, so that $v_* \circ h = 0$, whence $v_* = 0$.

Now, Theorem 2 for $X = N^+$. Let f be holomorphic on S. If $(\log^+|f|)\hat{}_S$ is quasibounded, then $[(\log^+|f|)\circ h]\hat{}_R = (\log^+|f|)\hat{}_S \circ h$ is quasibounded on R. The converse is true by the observation in the preceding paragraph. Thus, $f \in N^+(S)$ if and only if $f \circ h \in N^+(R)$. As the "norm" of $F \in N^+(R)$ we use $\|F\|_{w,N(R)}$ as in (i).

(iii) $X = H^p$. The Hardy class $H^p(R)$ $(0 < p < \infty)$ consists of f holomorphic on R such that $(|f|^p)\hat{}$ exists. The "norm" with the reference point $w \in R$ is

$$\|f\|_{w,H^p(R)} = [(|f|^p)\hat{}(w)]^{1/p}$$

see [7, p. 137], [8, p. 50]; this is actually a norm in case $p \geqslant 1$. Theorem 1 with $u = |f|^p$ establishes the present case. The norm identity is

$$\|f \circ h\|_{w,H^p(R)} = \|f\|_{h(w),H^p(S)} .$$

(iv) $X = H^p_\sigma$. The class $H^p_\sigma(R)$ $(0 < p < \infty)$ consists of f holomorphic and bounded, $|f| < 1$, on R such that the subharmonic function

$$\sigma(f)^p \equiv (\tanh^{-1}|f|)^p$$

admits an harmonic majorant on R. The "norm" with the reference point $w \in R$ is

$$[(\sigma(f)^p)\hat{}(w)]^{1/p} . \tag{3.1}$$

It is now easy to establish this case with the aid of Theorem 1 with $u = \sigma(f)^p$. It is known that $H^p_\sigma(R)$ is a complete metric space with metric relating to (3.1); see [13].

(v) A subharmonic function u on R is said to be of bounded mean oscillation on R, $u \in BMOS(R)$ in notation, if $u\hat{}_R$ exists and

$$\|u\|_{BMOS(R)} \equiv \sup_{z\in R}(\hat{u_R}-u)(z) < \infty .$$

This means that the potential p in the Riesz decomposition $u = \hat{u_R} - P$, is bounded on R. Let u be a subharmonic function on S majorizing a harmonic function there. Then $u \in BMOS(S)$ if and only if $u\circ h \in BMOS(R)$, and further, in this case,

$$\|u\circ h\|_{BMOS(R)} = \|u\|_{BMOS(S)} .$$

This is a consequence of Theorem 1 with the emphasis on (1.1).

(vi) $X = BMOA$. The terminology in (v) is justified by the following observations. According to Metzger [6] a holomorphic function f on R is said to be of bounded mean oscillation, $f \in BMOA(R)$, if

$$\|f\|_{BMOA(R)} = \sup_{w\in R} 2\pi^{-1}\iint_R g_R(z,w)|f'(z)|^2 dxdy < \infty .$$

In [11] we find the relation for f holomorphic on R:

$$(3.2) \qquad (|f|^2)\hat{}_R(w) - |f|^2(w) = 2\pi^{-1}\iint_R g_R(z,w)|f'(z)|^2 dxdy .$$

Thus, $f \in BMOA(R)$ if and only if $|f|^2 \in BMOS(R)$; in this case,

$$\||f|^2\|_{BMOS(R)} = \|f\|_{BMOA(R)} .$$

Theorem 2 for $X = BMOA$ now follows from (v) above. The quantity $\|f\|_{BMOA(R)}$ is called BMOA pseudo-norm of $f \in BMOA(R)$.

(vii) $X = BMOA_\sigma$. The situation is the same on replacing $|f'|^2$ by $|f'|^2/(1-|f|^2)^2$ and $|f|^2$ by $\lambda(f) = -\log(1-|f|^2)$ for f holomorphic and bounded, $|f| < 1$, on R. Thus, $f \in BMOA_\sigma(R)$ if $\|f\|_{BMOA_\sigma(R)} = \|\lambda(f)\|_{BMOS(R)} < \infty$. The equality follows from the analogue of (3.2),

$$\lambda(f)\hat{}(w) - \lambda(f)(w) = 2\pi^{-1}\iint_R g_R(z,w)|f'(z)|^2/(1-|f(z)|^2)^2 dxdy ;$$

see [11]. Again (v) proves the case $X = BMOA_\sigma$.

Remark. Let $L(R)$ be the family of meromorphic and Lindelöfian functions on R. It should be noted that Theorem 2 for $X = N$ yields the following result of Heins cited in the introduction. *For* f *meromorphic on* S, *we have* $f \in L(S) \Leftrightarrow f \circ h \in L(R)$. For the proof we may suppose that f is nonconstant. Let E be the set of all the poles of f on S. Then $S_E = S \setminus E$ and $R_E = R \setminus h^{-1}(E)$ both are hyperbolic Riemann surfaces. It then follows from [3, Theorem 16.1, p. 466] that the restriction of h, that is, $h: R_E \to S_E$ is again of type $B\ell$. On the other hand, it follows from Parreau's theorem [7, Théorème 20, p. 182] (this theorem is valid for $\alpha = 0$) that

$$f \in L(S) \Leftrightarrow f \in N(S_E) ;$$

$$f \circ h \in L(R) \Leftrightarrow f \circ h \in N(R_E) .$$

Therefore, $f \in L(S) \Leftrightarrow f \circ h \in L(R)$.

References

[1] Peter L. Duren, *Theory of H^p spaces* (Academic Press, New York, 1970).

[2] Otto Frostman, "Potentiel d'équilibre et capacité des ensembles avec quelques applications à la théorie des fonctions, *Meddel. Lunds Univ. Mat. Sem.* 3 (1935), 1-118.

[3] Maurice Heins, "On the Lindelöf principle", *Ann. Math.* 61 (1955), 440-473.

[4] Maurice Heins, "Lindelöfian maps", *Ann. Math.* 62 (1955), 418-446.

[5] Shōji Kobayashi and Nobuyuki Suita, "On subordination of subharmonic functions", *Kodai Math. J.* 3 (1980), 315-320.

[6] Thomas A. Metzger, "On BMOA for Riemann surfaces", *Canad. J. Math.* 33 (1981), 1255-1260.

[7] Michel Parreau, "Sur les moyennes des fonctions harmoniques et analytiques et la classification des surfaces de Riemann", *Ann. Inst. Fourier* 3 (1951), 103-197.

[8] Walter Rudin, "Analytic functions of class H_p", *Trans. Amer. Math. Soc.* 78 (1955), 46-66.

[9] John V. Ryff, "Subordinate H^p functions", *Duke Math. J.* 33 (1966), 347-354.

https://doi.org/10.1017/S0004972700009898 Published online by Cambridge University Press

[10] Shinji Yamashita, "On some families of analytic functions on Riemann surfaces", *Nagoya Math. J.* 31 (1968), 57-68.

[11] Shinji Yamashita, "F. Riesz's decomposition of a subharmonic function, applied to BMOA", *Boll. Unione Mat. Italiana,* (6)3-A (1984), 103-109.

[12] Shinji Yamashita, "Hyperbolic Hardy class H^1", *Math. Scand.* 45 (1979), 261-266.

[13] Shinji Yamashita, "On hyperbolic Hardy classes", *Comm. Math. Univ. St. Pauli* 30 (1981), 65-69.

Department of Mathematics,
Tokyo Metropolitan University,
Fukasawa, Setagaya,
Tokyo 158,
Japan.